TABLE OF CONTENTS
GEOLOGY. R645-301-600

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURE -(Continued)

LIST OF MAPS

R645-301-600. GEOLOGY.

610. INTRODUCTION.

A description of the geology and other related information is presented below for the Mine Permit Area.

611. thru 612. GENERAL REQUIREMENTS.

A description of the geology within and adjacent to the Mine Permit Area is presented within Sections 621 through 627 and the proposed operation within the mine area is presented in Section 630. All maps, plans and cross sections required by 622 have been certified and are presented in their appropriate section.

620. ENVIRONMENTAL DESCRIPTION.

The Mine Permit Area is located on the northern end of the Wasatch Plateau to the south and southwest of the town of Scofield in central Utah. The Geology Map 621a shows the location of the Mine Permit Area with respect to the town of Scofield. The Mine Permit Area lies in a rugged mountainous region characteristic of elevation ranges between approximately 7,800 feet and 10,200 feet above sea level. The Mine Permit Area is within the Wasatch Plateau coal field as well as partially within the Clear Creek gas field.

621. ENVIRONMENTAL REQUIREMENTS.

The Mine Permit Area lies in the northern end of the Wasatch Plateau, on the west flank of the Clear Creek Anticline (Doelling, 1972). As such, the dip of the strata is generally towards the west, ranging from about four to eight percent (two to five degrees). With the exception of local alluvial deposits, all of the units exposed on and immediately adjacent to the Mine Permit Area are Cretaceous members of the Mesaverde Group. The Star Point Sandstone, which is exposed at the surface in the east canyons, is approximately 1000 feet thick and nearly devoid of shale (Doelling, 1972). This yellow-gray (salt and pepper) beach sandstone is massive and medium-grained (Spieker, 1931). Immediately overlying the Star Point Sandstone is the Blackhawk Formation, an interbedded formation of sandstones and shales which is Utah's chief coal producer. The sands in this 1500- foot thick member are fine to medium grained and cemented by either calcite or silica with some iron discoloration. Sandstones of the Blackhawk Formation are more irregular than the sandstones of the Star Point. They also tend to be generally discontinuous in nature, local in extent, and have locally high clay contents (Spieker, 1931; Doelling, 1972). An exception to this is the Aberdeen Sandstone, a coarse-grained, light-colored sand with a thickness of 20 to 90 feet, which can be traced throughout the region (Spieker, 1931).

Spieker (1931) had identified three types of shale in the Blackhawk Formation, all continental in origin. The three types identified are, a common clay shale which is soft and granular, a carbonaceous shale, and a smoke-gray shale usually associated with local coal. As was the case with the sandstones, the shales are irregularly bedded (Spieker, 1931).

Most of the faults in the Mine Permit Area have a northerly trend. The faults within the Blackhawk Formation occur basically as zones (Doelling, 1972) with individual slips usually being clean, sharp displacements with little gouge. Both major fault zones in the Mine Permit Area are downdropped to the west and tend to die out to the north (U.S. Geological Survey, 1979). However, some smaller faults have the opposite displacement and create local horsts and grabens. The Connelville Fault forms the western boundary of the Belina Permit Area with a drop which varies from 190 feet at the western central permit boundary to 75 feet near Eccles Canyon (U.S. Geological Survey, 1979). The other major fault in the area, the O)Connor Fault, extends through the center of the Belina Permit Area and has a drop of about 350 feet (U.S. Geological Survey, 1979). The Pleasant Valley Fault generally runs parallel to Mud Creek and lies toward the western boundary of the Valcam Loadout Facility. General Geologic Map 621a is inserted to illustrate local geology.

MAP 621a. General Geologic Map

The dominant soils in the area are loamy and are moderately deep (20 to 40 inches) with thin, dark surface horizons (high in organic matter), medium-textured (loamy) surface layers, and moderately fine-textured (clay loam) subsoils. Coarse fragment contents tend to be high {35 to 50 percent). A small portion of the area also consists of gravelly and stony colluvial slopes, rock outcrops, and very shallow soils.

622. CROSS SECTIONS, MAPS AND PLANS.

The maps, plans and cross sections needed to clarify the geologic data required are presented within the appropriate section and were compiled utilizing the best information available. A summary of geologic mapping included within the permit is shown in Table 622a. The area of the White Oak Complex that will be mined by surface mining methods is identified on Plate 5-1C. A corehole BCC-1 was drilled in a location that depicts the maximum overburden and interburden that exists to be surface mined above the Upper and Lower O'Connor coal seams. This strata section is included on Figure 2 and the geologic log Appendix A of "Summary of Results on Toxicity Test for Barrier Coal Test Hole BCC-1" in Appendix 6-1.

622.100. TEST BORINGS AND CORE SAMPLINGS.

The locations and elevations of all drill holes in the Mine Permit Area are shown on Map 622.100a and summarized in Table 622.100a. Drill hole logs are available for those holes identified by a "*" in the table. Selected drill hole log information has been provided as part of this MRP according to the request made by UDOGM during a meeting held on October 24,1989. Logs selected for inclusion (as requested by UDOGM and agreed by the applicant) in this mine permit include 73-24-1,74-6-1,75-6-1,75-24-4,75-25-3,75-30-3, and 75-36-1. Copies of these well logs are identified in the 1993 Appendix 622.100 (marked confidential). The applicant considers all information related to these well logs to be confidential, and therefore has submitted this appendix separately from the remaining appendices of the mine permit. Locations of drill holes for the surface mine are on Plates 5-1D&E.

MAP 622.100a. Drill Hole and Gas Well Locations with Coal Seam Data

TABLE 622a
LIST OF GEOLOGIC MAPS

MAP or FIGURE	COMMENTS
621a	General Geologic Map
622. 100a	Map showing location and elevation of drill holes and Coal Seam thickness and depth, and Gas Well Locations.
622. 200a	Geologic Cross Sections, Coal Outcrop and Forest Service Subsidence Monitoring Location Map.
622.200b	Isopach Map of the Upper O'Connor Coal Seam.
622.200c	Isopach Map from the bottom of the Upper O'Connor to the top of the Lower O'Connor.
622.200d	Isopach Map of the Lower O'Connor Coal Seam.
622.200e	Isopach Map from the top of the Upper O'Connor Coal Seam to the surface.
622.200f	Stratigraphic Geologic cross section A-A'
622.200g	Stratigraphic Geologic cross section B-B'
622. 200h	Stratigraphic Geologic cross section C-C'
622.200i	Stratigraphic Geologic cross section D-D'
622.200j	Geologic/Hydrologic cross section M-M'
622.200k	Geologic/Hydrologic cross section N-N'
622.200l	Geologic/Hydrologic cross section O-O'
622.200m	Geologic/Hydrologic cross section P-P'

TABLE 622.100a
LIST OF EXPLORATION DRILL HOLES

DRILL HOLE NO.	LOCATION (SLB&M)	ELEVATION
EC-1	T13S,R6E SWNW Sec. 25	9076
EC-2	T13S,R6E NESW Sec. 24	8790
EC-3	T13S,R6E SENW Sec. 24	8763
EC-4	T13S,R6E NESW Sec. 24	8854
EC-5	T13S,R6E NESW Sec. 24	8857
EC-6	T13S,R6E SESW Sec. 24	8862.4

DRILL HOLE NO.	LOCATION (SLB&M)	ELEVATION
EC-7	T13S,R6E SESW Sec. 24	8904
73-19-1	T13S,R7E SWSW Sec. 19	9367.7
73-24-1**	T13S,R6E NENE Sec. 24	9255
73-30-1	T13S,R7E NWSW Sec. 30	9476
73-31-1	T13S,R7E SWNW Sec. 31	9276
73-31-4	T13S,R7E SWSW Sec. 30	9195
74-1-1	T14S,R6E NENE Sec. 1	9824
74-1-2	T14S,R6E NENE Sec. 1	9810+
74-1-3*	T14S,R6E NESE Sec. 1	8989
74-6-1**	T14S,R7E SWSW Sec. 6	9710
74-25-1	T13S,R6E SWSW Sec. 25	9561
74-36-1	T13S,R6E SWSW Sec. 36	9873
74-36-2*	T13S,R6E SENW Sec. 36	9676
75-6-1**	T14S,R7E NENW Sec. 6	9918.6
75-7-1	T14S,R7E SWSW Sec. 7	9770
75-7-2*	T14S,R7E SWSW Sec. 7	9823
75-24-4**	13S,R6E SESE Sec. 24	9432.7
75-25-2*	T13S,R6E NENE Sec. 25	9379.4
75-25-3**	T13S,R6E SWSE Sec. 25	9897
75-30-1	T13S,R7E NWNW Sec. 30	9240
75-30-2	T13S,R7E NWNW Sec. 30	9214
75-30-3**	T13S,R7E NWNW Sec. 30	9179
75-31-1	T13S,R7E SWNW Sec. 31	9423.1
75-31-2	T13S,R6E SENE Sec. 36	9195
75-31-5	T13S,R7E SWSW Sec. 31	9730
75-36-1**	T13S,R6E SWSW Sec. 36	9872.3
75-36-2*	T13S,R6E NESW Sec. 36	9939.5
75-36-3	T13S,R6E SESE Sec. 36	9896.2

DRILL HOLE NO.	LOCATION (SLB&M)	ELEVATION
76-24-1*	T13S,R6E SESW Sec. 24	8862.4
76-25-1*	T13S,R6E SWSW Sec. 25	9561
76-25-2	T13S,R6E NESW Sec. 25	9506
76-36-1	T13S,R6E NWNW Sec. 36	9582
BCC-1	T13S,R7E NWNW Sec. 30	9202

* Drill holes for which log information is available.
**Drill holes for which log information is provided in 1993 Appendix 622.100 (marked confidential).
+ Approximate Elevation.

622.200. NATURE, DEPTH AND THICKNESS OF STRATUM.

Information relating to the size, shape, thickness, depth and other information relating to the coal seams is contained on Maps and Figures 622.100a, and 622.200a through 622.200m. Additional information is presented through geologic logs to be discussed in Section 624.310. Section 624.100 contains a detailed stratigraphic description of a representative geologic section.

MAP 622.200a. Geologic Cross Sections, Coal Outcrop & Forest Service Subsidence Monitoring Location Map
MAP 622.200b. Isopach Map of the Upper O'Connor Coal Seam
MAP 622.200c. Isopach Map from the Bottom of the Upper O'Connor to the top fo the Lower O'Connor
MAP 622.200d. Isopach Map of the Lower O'Connor Coal Seam
MAP 622.200e. Isopach Map from the top of the Upper O'Connor Coal Seam to the Surface
FIGURE 622.200f. Stratigraphic Geologic Cross Section A-A'
FIGURE 622.200g. Stratigraphic Geologic Cross Section B-B'
FIGURE 622.200h. Stratigraphic Geologic Cross Section C-C'
FIGURE 622.200i. Stratigraphic Geologic Cross Section D-D'
FIGURE 622.200j. Geologic/Hydrologic Cross Section M-M'
FIGURE 622.200k. Geologic/Hydrologic Cross Section N-N'
FIGURE 622.2001. Geologic/Hydrologic Cross Section O-O'
FIGURE 622.200m. Geologic/Hydrologic Cross Section P-P'
FIGURE 622.200n. Surface Mining Stratagraphic/Geologic Cross Section

The thickness of the coal seams in the area of the surface mining activity is 20 feet for the Upper O'Connor and 24 feet for the Lower O'Connor. The interburden ranges from 80 to 88 feet and the overburden ranges from 5-165 feet. See stratagraphic cross section Figure 622.200n and cross sections on Map R645-301-527.160 Sheets A,B,C & D. The maximum depth coal will be recovered is between 230-240' in the pit corner around N 485,575 E 2,087,425. This is the Lower O'Connor seam.

622.300. COAL STRIKE, DIP AND CROP LINES.

The outcrop zone of the coal is depicted on Geologic Cross Section Map 622.200a and is based on the best information available. The strike and dip differs in different parts of the Mine Permit Area. However, the typical dip within the mine is 2.1 degrees in approximately a 225 degree direction. Additional information can be found by reviewing the coal contours shown on the Belina No.1 and No.2 Mine Progress Maps as well as through a review of the geologic cross sections presented in section 622.200.

622.400. GAS AND OIL WELLS.

There are four gas wells, part of the Clear Creek gas field located within the Mine Permit Area. These four wells are all operated by Cordillera Corp. and only the most northern well, in Section 19, is currently producing. The other three are shut in at the present time. Well locations and depths are shown on Map 622.100a and summarized in Table 622.400a.

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TABLE 622.400a
LOCAL GAS WELL DATA

LOCATION (SLBM)	DEPTH (ft)	STATUS	COMMENT
T13S, R7E, Sec. 19 NENW	4390	producing	producing from the Ferron
T13S, R7E, Sec. 30 SWSW	5820	shut-in	gas from the Ferron
T13S, R7E, Sec. 31 SWSW	9225	shut-in	gas from the Ferron
T14S, R7E, Sec. 6 SWSW	6222	shut-in	gas from the Ferron

623. ADDITIONAL GEOLOGIC INFORMATION.

The general geology of the Mine Permit Area is summarized in 621 and a more detailed stratigraphic description is given in 624.100. Additional information requested by this section is given within the applicable section to follow.

623.100. POTENTIALLY ACID OR TOXIC FORMING STRATA.

The rocks contained in the Blackhawk Formation, within which all units involved in the mining activity are a part, are made up of interbedded sandstone, sandy shale, shale and coal. Data available at this time do not suggest that there are any chemical problems with any of these rock types which would be potentially acid or toxic forming.

The core of hole BCC-1 was tested for toxicity and the results are included in Appendix 6-1. The results of this testing determined that most intervals had a high net neutralizing capacity. One zone sixty feet above the Lower O'Connor seam has an ABP of 6.5 t/kt which was the highest acid producing potential, but this is well above the -5 t/kt criteria level. The selenium level was higher than other zones tested and this zone will be intermixed and placed outside of the rooting zone and will not be placed directly or adjacent to drainages or stream channels.

Previously, there had been limited soil sampling work completed in the Belina Mine Area, with more extensive sampling and testing within the adjacent Coastal States Energy Mines (located to the west of the Belina Mines on the west side of the Connelville fault). An Order 1 soil survey was completed in May of 2001 and the results are included in Appendix 2-1. The earlier sample results from the Belina Mines gave a good indication of the general chemical makeup of the strata as far as the analysis was done. The soil material which was sampled and analyzed was generated during the facing-up of the coal seams in preparation for mining. This material, therefore, is made up of the strata above, below, and between the coal seams so the soil samples discussed herein should be representative of these strata. A selected summary of data collected is presented in Table 623.100a, and sampling locations and original data sheets are included as 1993 Appendix 623.100a. A letter dated September 16, 1986 from James S. Leatherwood (a reclamation soils specialist) indicating the suitability of the Belina pad materials as a topsoil substitute can be found in 1993 Appendix 221. In his letter, Mr. Leatherwood also indicated that material located at the Valcam Loadout Facility would also serve as a topsoil substitute (Vegetation-supporting Material) if needed.

1993 Appendix 623.100a contains the results of analysis of two sets of samples. The first set of samples was taken from bore holes BP-1 and BP-2 and were analyzed by MIDECO in early 1983. These results show unusually high concentrations of boron and copper. The second set was taken from test holes No.1, No.2, and No.5. These samples were analyzed by Ford Chemical Laboratory in late 1983 and show normal low concentrations of boron and copper. The reason for the abnormally high concentrations reported for the first set of samples is not known and can probably not be determined because MIDECO is no longer in business.

Information gleaned from the Coastal States Energy Permit Application (applicable to the area west of Valley Camp of Utah's operation) indicates that 1) the lithology of the strata immediately below the minable coals vary from drill hole to drill hole, 2) that the clay content varies from nearly 100% in pure claystones to less than 5% in sandstones, and 3) a slight alkalinity and low sulfur content exists in the roof strata. For more information the reader is referred to the Coastal States Energy Permit Application on file with the regulatory agency.

The soil sample work discussed above indicates that the molybdenum levels are below 0.185 ppm, selenium levels are below 0.025 ppm, acid-base potentials range from 10.3 to 55.5, and that pH of the soil samples range from 7.2 to 8.8 with one exception where the pH reached a low of 5.5. Additional information can be gleaned from the data presented in 1993 Appendix 623.100a.

Normal mining operations at Valley Camp result in coal being left on the roof and the floor of mine openings because the equipment used cannot extract the full thickness of the coal seam. As a result the rocks above and below the coal seam are not extracted and brought to the surface. This eliminates the possibility of contamination at the surface by this material. Since these strata remain in-place within the mine there is no more than the normal natural effect on the environment by these strata so the geochemical characteristics of the strata are irrelevant to the protection of the environment at the mine site. Also since the roof and floor rocks are not exposed during mining, Valley Camp has not generally been in a position to obtain current or on-going samples of these strata.

In order to better document the acid and or toxic forming potential of coal at the Belina Mines, the applicant collected samples of coal which is shipped from the Valcam Loadout Facility biannually and have it analyzed for acid-toxic forming potential. A copy of the results of these analyses was forwarded along with a cover letter to UDOGM within 30 days of receipt by the applicant. During October, 1992, a composite sample of coal was taken and, analyzed, the results of which are reported in 1993 Appendix 623.100b. According to Division Guidelines (Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April, 1988) the coal is classified as "Good". Should it be determined that acid-toxic forming materials exist, the applicant agrees to investigate further the location of the material, and to comply with the appropriate State and Federal requirements.

TABLE 623.100a
GEOCHEMICAL RESULTS FROM SOIL SAMPLES (ppm)

Sample Location	Depth Interval (feet)	B	Ca	Cu	Fe	Mg	Mn	P	K	Na	Zn
TH-1	0-2	0.06	4500	0.25	66.5	15.81	14.5	20.6	114.0	0.42	1.7
	2-4	0.12	3450	0.10	68.3	15.33	12.6	31.4	95.0	0.51	2.4
	4-6	0.09	3870	0.30	59.2	14.26	10.5	4.5	81.0	0.72	1.9
	6-8	0.01	3600	0.05	77.5	17.26	6.7	16.2	110.0	0.85	2.3
TH-2	0-2	0.06	2700	0.20	51.5	21.4	4.9	16.5	110.0	0.30	1.0
	2-4	0.01	3870	0.27	45.6	15.7	8.6	26.4	86.0	0.51	1.9
	4-8	0.11	4390	0.30	44.9	17.3	9.3	25.4	79.0	0.54	2.0
	0-2.5	0.26	4600	0.02	56.5	14.8	9.2	12.9	112.0	0.69	1.8
	2.5-5	0.17	4200	0.09	54.2	14.4	6.8	15.6	95.0	0.52	2.0
	5-7.5	0.24	3770	0.10	63.5	13.8	4.9	8.7	86.0	0.65	1.8
	7.5-10	0.17	3920	0.15	74.1	13.6	8.3	16.2	69.0	0.78	7.1
	10-12.5	0.12	3700	0.28	58.9	13.1	9.5	11.4	72.0	0.43	7.5
	12.5-15	0.10	3490	0.03	66.9	10.5	11.6	10.5	105.0	0.47	2.2
	15-17.5	0.26	2960	0.05	71.4	13.6	9.5	14.5	120.0	0.38	1.3
	17.5-20	0.41	4130	0.10	75.2	15.2	8.5	21.6	119.0	0.50	1.5
	20-22.5	0.17	3590	0.24	61.5	13.7	6.8	15.5	88.0	0.52	1.2
	22.5-25	0.14	3150	0.25	59.5	14.4	8.5	11.5	79.0	0.65	2.1
	25-27.5	0.07	4025	0.42	45.5	14.5	11.2	30.7	96.0	0.45	1.7
	27.5-30	0.10	3960	0.46	43.8	15.2	10.9	29.2	91.0	0.50	1.8
BP-1	0-5	27	11500	18.0	-	-	-	-	-	250	-
	5-6.6	23	5600	16.0	-	-	-	-	-	360	-
	6.6-10	41	37300	16.0	-	-	-	-	-	150	-
	10-15	34	21700	8.0	-	-	-	-	-	100	-
	15-20	24	8900	6.0	-	-	-	-	-	90	-
	25-26	20	700	10.0	-	-	-	-	-	90	-
	16-27	43	1800	20.0	-	-	-	-	-	110	-

TABLE 623.100a
GEOCHEMICAL RESULTS FROM SOIL SAMPLES (ppm)

Sample Location	Depth Interval (feet)	B	Ca	Cu	Fe	Mg	Mn	P	K	Na	Zn
	27-28	18	1000	14.0	-	-	-	-	-	35	-
	28-29	24	4400	21.0	-	-	-	-	-	110	-
	29-30	18	1900	22.0	-	-	-	-	-	140	-
	40-41.5	39	33700	12.0	-	-	-	-	-	120	-
BP-2	0-3	20	1500	14.0	-	-	-	-	-	30	-
	5-8	21	1300	14.0	-	-	-	-	-	60	-
	8-13	16	500	17.0	-	-	-	-	-	86	-
	13-18	15	700	7.0	-	-	-	-	-	37	-
	18-23	30	800	6.0	-	-	-	-	-	110	-
UT-1	10	0.8	5	0.5	15.1	1.7	9.4	17.4	123.0	1.2	1.1
UT-2	8	0.9	8	0.4	16.6	2.4	13.3	13.7	69.0	1.3	1.1
UT-3	6	0.8	2	0.8	59.3	0.4	7.5	8.7	68.0	0.9	0.7

* TH - i identifies test holes located at the Belina Mine.
BP - i identifies locations of roof and floor bore holes at the Belina Mine.
Ut - i identifies sampling sites located at the Valcam Loadout Facility

The area to be surface mined at the White Oak Complex has results of core BCC-1 tested for toxicity and the results are included in Appendix 6-1. The coal seams were tested in 1992 and the results are found in Appendix 623.100b. Both the rock material that makes up the overburden and the interburden was found to have a high neutralizing capacity. None of the results indicated a potential for toxic metal leachate from the waste rock. The coal also tested in the good range for not being toxic.

623.200. RECLAMATION.

Geologic information is presented within the permit application in sufficient detail to comply with the reclamation activities proposed herein as part of the permit.

623.300. SUBSIDENCE.

The Subsidence Control Plan under the Underground Coal Mine and Reclamation activities is presented in 1993 Appendix 724.600.

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624. GEOLOGIC INFORMATION.

A discussion of the general geology of the Mine Permit Area is presented in 621. The geologic information provided in the following sections gives detailed stratigraphic descriptions and relates the geology to the movement of ground water. Information contained within this geologic section of the MRP is based upon general geologic expertise and reports prepared for the applicant by engineering and geologic consultants. Literature used in the preparation of this permit are included in the reference section of the permit.

624.100. GEOLOGIC DESCRIPTION.

All of the stratigraphic units exposed in the Mine Permit Area are part of the Mesaverde Group. The lowest geological unit in the Mine Permit Area is the Star Point Sandstone which is overlain by the Blackhawk Formation. It is within the Blackhawk Formation that local coal seams are found. A general geologic cross section showing the information discussed below is found in Stratigraphic Figure 622.200f. Additional maps and cross sections which may be useful to the reader are identified in Section 622. The plans for reclamation of the Mine Permit Area are presented in the "Reclamation Plan" volume of this permit submittal.

STAR POINT SANDSTONE FORMATION

The Star Point Sandstone, the lowest unit exposed in the Mine Permit Area, is a yellow-gray (salt and pepper) beach sandstone with massive beds and is medium-grained (Spieker, 1931). The Sandstone unit is exposed locally on the eastern edge, as well as to the east of the Mine Permit Area. The Star Point Sandstone is extremely tight and yields water in quantities of generally less than 5 to 10 gpm except where fractured. See page from the Star Point Sandstone is, however, an important part of the base flow to the stream in Eccles Canyon.

The Star Point Sandstone is thicker than normal in the Mine Permit Area and is over 1000 feet thick. The unit is a yellow-gray sandstone with beds that are mostly massive with occasional partings of shale or shaley sandstone. The amount of shale present is minor.

BLACKHAWK FORMATION

The Blackhawk Formation (which lies above the Star Point Sandstone unit) is the main unit in the Mine Permit Area and, in fact, is the main coal bearing unit in the region. The unit is approximately 1500 feet thick with the better coal seams being located within the lower 380 feet of the formation. The Blackhawk Formation is an interbedded formation of sandstone and shales. The sandstone beds are generally massive while the shale layers act bentonitic, tending to swell when wet and decomposing into a semi-impervious clay. The sands in this member of the Mesaverde Group are fine to medium grained and cemented by either calcite or silica with some iron discoloration. The sands are also more irregular than the sandstones typical of the Star Point Formation, tending to be local in extent and having locally high clay contents (Spieker, 1931; Doelling, 1972). The Aberdeen sandstone is a coarse-grained, light-colored sand with a thickness of 20 to 90 feet, which can be traced throughout the region (Spieker, 1931). The generally discontinuous nature of the Blackhawk sands is only locally important for groundwater since a well defined ground water aquifer capable of moving relatively large volumes of water does not exist.

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 OCT 26 2001

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Spieker (1931) has identified three types of shale in the Blackhawk Formation, all continental in origin. The three types are 1) a common clay shale which is soft and granular, 2) a carbonaceous shale and 3) a smoke-gray shale usually associated with the coal. As was the case with the sandstones, the shales are irregularly bedded (Spieker, 1931).

Stratigraphic Description

A drill log from drill hole 75-24-4 (shown on Figure 622.200g) is used to describe the lower part of the Blackhawk Formation, which is the most important portion of the formation with respect to coal mining operations in that it is within the lower zone where the mined coal is located. Drill hole 75-24-4 is located in the SE quarter of the SE corner of Section 24, T13S,R6W, SLBM as shown on Drill Hole Location Map 622. 100a. This log provides a representative geologic stratigraphic section of the Mine Permit Area. The discussion that follows (related to the analysis of the log) starts at the bottom of the unit, and continues upward.

The lowest coal seam of the Blackhawk Formation in the vicinity of the Mine Permit Area is the Flat Canyon coal seam which lies approximately 50 feet above the Star Point Sandstone Formation. The Flat Canyon coal seam is not present over the entire Mine Permit Area, but in the area of drill hole 75-24-4 is found to be separated into two seams. The upper seam is one foot thick and is separated from the lower two foot thick seam by an eight foot shale layer. The 89 foot thick Aberdeen Sandstone layer lying above the Flat Canyon coal seam consists mostly of sandstone with some interbedded shales. It is described as a massive, irregularly bedded, gray to brownish quartzose sandstone and being medium to very fine grained. It is also known to have some local carbonaceous material present.

The Aberdeen Sandstone tends to grade upward from fine-grained at the base to medium and course-grained at the top and contains thin shaley intervals near the base. The conspicuously white upper few feet of the sandstone are significant because they generally lie immediately beneath the lowest minable coal seam. The chalky white appearance and the texture of this interval are similar to the uppermost part of the Star Point. The white color is imparted by the presence of the clay matrix which apparently formed diagenetically due to the action of acid waters from the overlying coal swamp, or as a result of subaerial weathering.

The Lower O'Connor coal seam overlies the Aberdeen Sandstone unit and at drill hole 75-24-4 is 22.5 feet thick. The Lower O'Connor ranges from 7 to 28.5 feet thick in the Mine Permit Area and contains a two-tenths of a foot thick fine grained sandstone bed within the coal seam. A thin clay seam lies above the top of the coal seam which in turn lies beneath 74 feet of medium to fine grained quartzose sandstone with minor interbedded shale. The quartzose sandstone unit has interbedded brown to reddish brown and gray to white lenses and is referred to as massive and irregularly bedded, while containing some local carbonaceous material. Lying above the 74 foot thick sandstone layer is a 1.5 foot seam of coal which in turn lies beneath 22 feet of sandstone. This upper 22 foot sandstone layer is similar to the 74 foot thick layer just discussed except that it contains more shale beds.

The next geologic unit encountered as we move upward is the Upper O'Connor coal seam. At this location, this coal seam is approximately 22 feet thick and is broken into three sections. The lower portion of the seam consists of six feet of coal followed by nearly four feet of light gray, fine grained, varied (layered) sandstone. Above this sandstone is 9.3 feet of coal followed by two feet of sandstone and then by one foot of coal. The next 406 feet of stratum between the last one foot of coal discussed and the surface, are made up of interbedded light to dark gray with some buff and tan colored shale, sandstone, and siltstone. The McKinnon coal seam is missing in the area of the geologic section, but would generally be located within this 406 foot section. In other areas the McKinnon seam is located approximately 350 feet above the Upper O'Connor seam and is found to be up to 11 feet thick. Much of the McKinnon seam, however, is very thin and is not mined. Other thin coal seams are also locally present in this interval.

FAULTNG

Three major north-south tending faults are found locally within or adjacent to the Mine Permit Area. The three faults are the Connelville Fault, the O'Connor Fault, and the Pleasant Valley Fault. As mining progressed within the Belina Mines, a series of smaller step faults not previously known to exist were found to be parallel to, and east of, the main Connelville Fault. Other faulting in the Mine Permit Area has also been encountered that was not previously mapped. The locations of local faults were discussed previously in Section 621 and are shown on General Geologic Map 621a in plan view. The geologic cross sections included within this submittal also include faults when encountered in the section. Information concerning the dip of local faults is sparse, however, information that is available seems to indicate that they are vertical or near vertical in most areas.

In addition to the three major north-south tending faults discussed above, there are some smaller easterly trending faults in the area, some of which have been intruded by dikes. The locations of these faults are also shown on General Geologic Map 621a. These dikes are classed as amprophyes. The major dike passing through the mining operations was found to have coked coal near the contact. This dike is located within the southern half of section LA approximately three quarters of a mile south of the Belina Mines tunnel entrances. Some increase in metal content was also noted near the contact face including higher than normal pyrite contents in the coal.

GEOLOGIC EFFECTS UPON WATER MOVEMENT

The principle factor controlling the occurrence and availability of ground water in any area is lithology. Nearly all of the region surrounding the Mine Permit Area is underlain by rocks of continental and marine origin, consisting predominately of interbedded sandstones and shales (Price and Waddell, 1973). Although some of the sandstones in the region serve as water bearing strata, their ability to yield water for extended periods of time is largely controlled by the existence of the relatively impermeable interbedded shale layers, which prevent the downward movement of a significant amount of water. Because of this condition, specific areal extents, depths and thicknesses of aquifers are not easily defined. Price and Arnow (1974) state that the volume of recoverable water in the area is small, averaging less than 600 acre-feet per square mile in the upper 100 feet of saturated rock.

Surface water flow is affected by the geology to the extent that varying geologic structures control the infiltration of ground water. As stated, many of the sandstones and shales present within the Mine Permit Areas impede the infiltration of ground water. On the other hand, faults, fractures, and alluvial fill, where they exist, enhance infiltration thereby reducing net surface runoff. The dominant fault trends in the Mine Permit Area are in a north-south direction, however, smaller fault systems are noted locally to have an east-west orientation. It is suspected that faulting has only local hydrologic importance within the Blackhawk Formation because of the high clay content of surrounding materials which tends to seal the fractures and either restrict or stop water movement. Fracturing within the lower Star Point Sandstone

Formation, however, is not impacted greatly by clays, and therefore secondary permeability created by fracturing tends to increase local water yielding capabilities of this lower system.

Mining within the Blackhawk Formation has shown that faults may, but do not necessarily, provide conduits or a "plumbing system" for transporting groundwater. Investigations have shown that large volumes of water are not produced from faults unless a tension crack associated with a fault has provided an open channel that can drain adjacent sandstone and readily convey water into the mines. Wells drilled into the Blackhawk and Star Point Formations produce very little water (usually less than 5 gpm) unless a water conducting fracture(s) is.encountered. Consequently, the culinary water supplies for both the Belina Mines and the adjacent Coastal States Energy Mines are obtained from wells drilled into faults in the Star Point Formation. Early culinary wells drilled for the Coastal States Energy Mines produce less than 10 gpm. Only when a well was drilled into the Connelville Fault zone was an. adequate water supply developed. The culinary water supply well for the Belina Mines was drilled into the O'Connor Fault, from which it derives a moderate flow (maximum rate -65gpm).

Another geologic phenomenon capable of altering water movement is caused by "rolling" of a formation. As formations develop waves or rolls through compression or vertical displacement, tension stresses result in the development of cracks which may collect and convey water within the formation. These cracks are generally local in nature and are not as extensive as the local faulting system. The combined effect of faulting and rolling in the formations containing coal seams may create secondary permeability zones which (when compared to most areas in the Blackhawk) would result in higher than anticipated ground water inflow into the Belina Mines.

Examples of these secondary permeabilities are given at the various locations within the mines which have experienced higher than anticipated inflows during mine advancement. Documented inflows over the period of mining are:

- An inflow of approximately three gallons per minute located at about 1,500 feet inside the mine in a northwest direction from the main mine portals.

- An inflow of approximately two gallons per minute located at about 1,500 feet inside the mine in a west-southwest direction from the main mine portals.

- An inflow of approximately ten gallons per minute was noted when a fault was encountered at about 2,600 feet inside the mine in a west-northwest direction from the main mine portals. At approximately 2,000 feet further south along this same fault, there was encountered again another inflow of approximately five gallons per minute. When the fault was encountered for the third time at a distance of approximately 1,500 feet farther south, no water inflow was reported.

- Water inflow was encountered in the area located approximately 2,500 feet south-southwest of the mine portal when a major roof fall occurred. The roof fall was located in a fault zone with a four foot displacement. No other local water was encountered.

Roof falls at other locations have been encountered without the production of water. It appears that water within the mines is generally related to either a zone of shallow overburden, or to a roll in the rock which produces tension cracking. Normal faults generally do not produce water. Large flows occurring within the mines are generally associated with tension cracking, and usually reduce in flow volume over time as the adjacent sandstone is drained.

The abundance of shale in the Blackhawk also acts as an effective barrier to the downward movement of water within the formation, greatly reducing its overall vertical permeability and the amount of water which percolates through the formation to lower units. Water which reaches the Blackhawk percolates downward until it meets a shale layer, after which the water moves horizontally to the surface or another "drain" (i.e. sandstone finger, fault, etc.) within the formation. Investigations at springs and streams in the Mine Permit Area have confirmed that shale layers impede downward percolation of water through the Blackhawk, and that springs are generally located where shale layers outcrop. The fact that most springs are on fairly steep hillsides and not in channel bottoms where a regional aquifer would tend to discharge, provides additional evidence that the springs in the upper elevations of the Blackhawk Formation are draining perched aquifers. These springs tend to receive water from localized rather than regional sources.

A major east-west dike crosses the Mine Permit Area in the Boardinghouse Canyon "area. At the location encountered within the Belina Mines, the dike was found to be approximately 230 feet thick. It is believed that this dike was formed subsequent to local faulting. The dike was essentially dry at the time it was encountered, and it is felt that the dike itself may be creating a partial barrier to the movement of ground water. This theory is based upon the fact that at the time the dike was encountered within the mine, essentially no water was noted on the north contact face. However, upon traversing the dike, a small amount of dripping was noted to occur from the south contact zone, indicating the presence of local water. After coming in contact with the dike, local ground water may be moving along the contact face in an east-west direction parallel to the dike.

In determining the magnitude of the effects of mining on areal hydrology, it is important to recognize the uses of the hydrologic resources. Within the Mine Permit Area, the principal use of the hydrologic resources is for the watering of livestock and wildlife. The area has numerous springs, seeps, and several streams. The disturbance of some of these sources may result in the need for livestock and wildlife to utilize another adjacent source. However, this has not appeared to be a problem for local livestock and wildlife because of the many local sources which exist within the area.

Additional hydrologic details related to both surface and ground water are given in Section 700.

624.200 thru 624.230. REQUIREMENTS WHEN STRATA ARE EXPOSED.

The area to be surface mined at the White Oak Complex has results of core BCC-1 tested for toxicity and the results are included in Appendix 6-1. The coal seams were tested in 1992 and the results are found in Appendix 623.100b. Both the rock material that makes up the overburden and the interburden was found to have a high neutralizing capacity. None of the results indicated a potential for toxic metal leachate from the waste rock. The coal also tested in the good range for not being toxic.

624.300 thru 624.340. ANALYSIS OF CORES AND BORINGS.

DRILL LOGS

A limited number of drill logs are available for the Mine Permit Area. However, the nature of these data is such that presenting all available data in this report is impractical or impossible without extensive modifications in format. As an alternative, the information given by the logs not duplicated herein, is incorporated into the geologic sections described in Section 624.100. Drill hole logs and ground water information are presented on geologic cross sections 622.200f through 622.100m. BCC-1 in Appendix 6-1 was specifically drilled for testing for the surface mining activity.

CHEMICAL ANALYSES

Chemical analyses of the coal seams that are or have been mined, as well as of the strata above and below the coal seams are summarized in Section 623.100 and in reports included in Appendix 6-1 which specifically addresses the area of the surface mining activity.

GEOLOGIC PROPERTIES

As discussed above in 623.100 normal mining practice at Valley Camp leaves coal on both the roof and floor of the mine openings so that clay material above or below the coal seams is not exposed and does not directly affect the stability of the mine opening except in very limited and localized areas as discussed below.

Mining has been accomplished mostly by conventional room and pillar methods. The coal pillars are generally competent and the roof areas are stable where at least two feet of coal were left. Occasionally, roof falls have occurred in areas where less than two feet remained following mining. These roof falls have been more common in zones where the coal and shaley roof layers have been fractured by local faults. During mining, these zones are stabilized with roof bolts. Stabilization using roof bolts has been generally successful. Some areas have also been noted where a few inches of local clay have been found to exist above the coal seam.

Various reports prepared for the applicant by consultants have provided valuable information related to geology and related material properties. Pertinent information from these reports has been subtracted from them and is presented in the remaining information within this section. According to these reports, the material properties of the coal used as calculation factors for uniaxial strength, friction angle, and 52 degrees unit weight are 1431 psi, 52 degrees, and 85 pcf respectively. The factor used for the unit weight of the overburden is 150 pcf.

The pre-mining stress condition in the coal deposit was found to be as expected. The vertical stress is approximately equivalent to that of the overburden load, and lateral stresses are about one-third to one-half of the vertical stress, which is typical for gravity structures.

The direct measurement of stress in a coal seam has been one of the most difficult tasks of rock mechanics. For this reason, stress measurements from adjacent rock layers have sometimes been used in design. However, stresses in roof and floor rock are necessarily different from those in the coal seam because of the difference in properties, and the difference in the rate of stress relief through geologic time since deposition. Care must be taken therefore when using rock stress in the design of coal pillars.

A borehole deformation gage (BDG) was used to measure absolute stress in the coal mass. The BDG actually measures the change in the EX-size drill hole diameter as the stress around the drill hole is relieved by over-coring with a six-inch diameter coring bit. Measured deformations are used in the calculation of two dimensional stresses perpendicular to the drill hole axis. When three sets of these stresses are obtained from three drill holes having different orientations, both the magnitude and the three dimensional orientation of stress can be calculated.

Borehole deformation monitoring is referred to as an over-coring test. The equipment for an over-coring test consists of a drilling unit and a BDG unit. Auxiliary tools are also used to facilitate recovery of cores and insertion and positioning of the gage. The procedure has been standardized with slight variations in the intervals of strain reading during over-coring.

The first set of stress measurement consisted of over-coring of three holes drilled in three different orientations. The first of the three holes was drilled nearly perpendicular to the rib. In this drill hole, measurements were taken at every two to three feet of depth.

Preliminary analysis of the results from the three drill holes at the first site indicates that the pre-mining stresses are within the expected ranges for a sedimentary rock formation. There appears to be no tectonic influence in this area. Visual observations of the ground conditions in the Belina No.1 Mine did not detect unusual stress conditions. The results of the test are shown in Table 624.340a.

Monitoring of short cockle gages indicated that there was virtually no separation of the immediate roof. The horizontal strain of the roof as indicated by HORST data confirms this. The roof-floor convergence measured with a tape extensometer shows a very slow and gradual closure. However, a sudden closure of 0.1 to 0.15 inches was indicated when active mining was done near the test area. Estimating that one-half of this closure was due to pillar deformation, the data implies that a 200 to 300 psi load was added to the pillars during active mining.

The gages indicated impending changes in the ground conditions for 10 to 20 days prior to a roof fall. Gages closer to the fall gave longer advance warning. Additional anomalies appear to be reflections of small roof falls near a fault.

The influence on Belina No.2 Mine was also observed as part of the test. The results from the instrument monitoring in the test panel indicated that the roof sagging (flexure) is minimal. Visual observations of the mined-out area over a one-month period showed little change during that time. No roof or floor puncturing by the pillar was evident. These factors indicate the existence of a strong roof and floor. A strong roof or floor tends to dissipate the stresses rapidly thereby minimizing stress concentration. In addition, the overburden load in Belina No.1 does not appear to cause a buildup of abutment pressures in the next panel area.

TABLE 624.340a
SUMMARY OF MINING TEST STRESS MEASUREMENT DATA

Site No.	DH Angle No.	Measured Depth Ft.	Deformation, in 10^{-6}			Two Dimensional Stress		
			Vertical U_1	45° Left U_2	45° Right U_3	T, psi	Q, psi	T, deg
1	1	1.0	14508	12320	6950	2251	1502	22
		5.0	8399	5320	7506	1331	1027	-21
		14.0	2232	3780	4170	664	467	5
		22.0	2790	4200	0	594	183	40
	2	20.5	2344	3920	723	541	234	45
	3	21.0	4743	1960	2780	664	389	-8
2	4	1.5	5792	4967	4242	908	759	14
		3.5	7647	7949	6341	1301	1137	35
		5.1	4218	5113	1818	783	455	38
		7.2	2854	4346	2830	641	474	-30
		13.4	3119	3931	2897	605	500	-36
3	5	5.1	10184	3365	7784	1517	852	-20
		6.7	6350	3310	6144	1041	714	-28

The factors discussed above indicate that conditions in the lower seam of the Belina No.2 Mine will not be affected excessively by upper seam mining. The lower seam roof (floor of upper seam) appears to be sufficiently stable to achieve an evenly distributed load transfer. However, the pillars having the same dimensions as those in the upper seam would be less stable in the lower seam, due to increase in, depth and to some amount of stress concentration.

The Belina No.2 Mine has been partially developed below the West Mains of the Belina No.1 Mine. The main entries in the Belina No.2 Mine have been in a stable condition since the opening. As overburden increases, entries directly beneath the Belina No.1 Mine show signs of deterioration, and narrow corner edges of pillars begin to spall. Within a fault zone, the roof may cave in more easily than in the upper seam. Without precautionary measures, cavings tend to be more extensive since the pillars deform more. Otherwise, the ground conditions in the lower seam should be similar to those in the upper seam mine.

If the pillars are left in a regular pattern, and if they have consistent dimensions, no extraordinary support system should be required for the lower seam. However, a method will need to be developed for pre-supporting the faulted/ fractured zones.

625. ADDITIONAL GEOLOGIC INFORMATION.

The surface mining operation and reclamation will disrupt the water flows of a spring and several seeps currently located in the present highwall. Lodestar believes this water flow though minor in quantity will resurface at a different location and elevation along the spoil. The Whisky Creek channel is lower in elevation than the coal to be removed and it will ultimately report to the creek.

626. REQUEST FOR VARIANCE FROM SECTIONS 624.200 AND 624.300.

No waiver of Section 625 is required or requested at this time.

627. OVERBURDEN THICKNESS AND LITHOLOGY.

The Blackhawk Formation, as discussed earlier in this geologic section is exposed over most of the Mine Permit Area. The Blackhawk is made up of interbedded sandstone and shale beds. This interbedded material is the lithology that makes up the overburden over the mined areas. The thickness of the overburden varies within the Mine Permit Area. In some areas the coal is exposed at the surface and in three drill holes the top of the Lower O'Connor coal seam is over 1100 feet deep. An isopach map of the overburden thickness is presented as 622.200e.

630. OPERATION PLAN.

The overall plan is discussed in Chapter 5 - Engineering in Section 520. In effect, the underground mining activities will continue until the recovery of the economically mineable reserves are depleted. Surface activities during this phase will utilize existing buildings, facilities, utility corridors, coal storage, cleaning, and loading areas. Once, the underground portion of the mineral recovery is complete, the barrier coal located at the portals will be recovered by surface means during the reclamation process of the highwalls developed for the underground access. Water and subsidence monitoring will continue utilizing the control points that have been presented within other sections of this permit.

631. CASING AND SEALING OF EXPLORATION HOLES AND BOREHOLES.

All exploration drill holes have been plugged using the procedures required by the U.S. Forest Service. The drill holes were filled with drill cuttings except in specific areas of the hole requiring concrete plugs. Concrete plugs are required, and were extended ten feet above and below any aquifer encountered, as well as being placed across all coal seams. In the vicinity of the surface, all drill holes were backfilled with at least a five foot concrete plug upon which a soil layer was added to conform to local soil conditions.

When plugged, the culinary water well being used by the applicant will be plugged with either 1) bentonite to within five feet of the surface whereafter a concrete plug will be placed, or 2) concrete to the full depth of the well. In either case, this work will be done as part of the site reclamation.

631.100. TEMPORARY CASING AND SEALING.

There has been no need for temporary casing or sealing since all existing abandoned drill holes have been plugged.

631.200. PERMANENT CASING AND SEALING.

Since there has been no temporary completion of drill holes there is no need for permanent casing or sealing in addition to that discussed in Section 631.

632. SUBSIDENCE MONITORING.

Information related to subsidence monitoring can be found within 1993 Appendix 724.600.

640 thru 642. PERFORMANCE STANDARDS.

All exploration holes and boreholes have been permanently cased and sealed according to 631 and as required by the U.S. Forest Service. All monuments and surface markers will also be reclaimed upon termination of all mining operations.

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Price, D., and T. Arnow. 1974. Summary Appraisals of the Nation's Ground Water Resources - Upper Colorado Region. U.S. Geological Survey Professional Paper 813-C. Washington D.C.

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U.S. Geological Survey. 1979. Development of Coal Resources in Central Utah, Final Environmental Statement. Salt Lake City, Utah.

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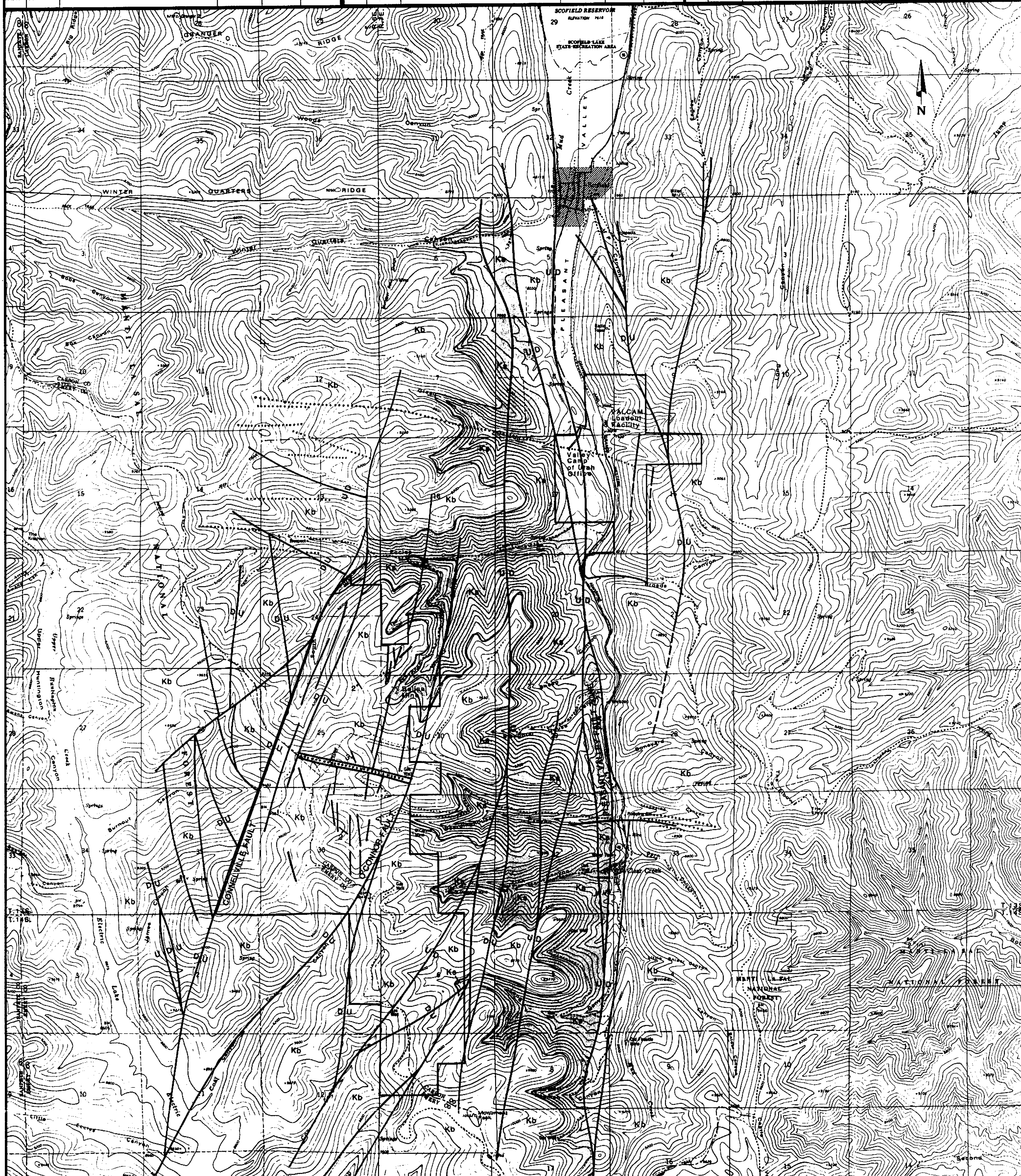
NO.	DATE	DESCRIPTION	REF. NO.	DATE	INITIALS	NO.	DATE	DESCRIPTION	REF. NO.	DATE	INITIALS	NO.	DATE	DESCRIPTION	REF. NO.	DATE	INITIALS



CERTIFICATION

I certify that this map was reproduced according to the best geologic information available as provided by Valley Camp of Utah, Inc.

LEGEND:

TERTIARY(?)

LAMPROPHYRE DIKE

CRETACEOUS

Kb BLACKHAWK FORMATION

Ks STARPOINT SANDSTONE

FAULT DASHED WHERE INFERRED SHOWING RELATIVE MOVEMENT WHERE KNOWN

STRIKE AND DIP OF BEDS

THE TOWN OF SCOFIELD

NOTE: INFORMATION PROVIDED IS EXTRAPOLATED FOR AREAS ON AND ADJACENT, TO PERMIT AREAS. GEOLOGY NOT SHOWN FOR BORDER AREAS OF MAP.

REGISTERED PROFESSIONAL ENGINEER #7888 DAVID E. HANSEN STATE OF UTAH

VALLEY CAMP OF UTAH, INC.

SCOFIELD ROUTE, HELPER, UTAH 84526

TITLE: MAP R645-301-621a GENERAL GEOLOGIC MAP

Drawn by: VALLEY CAMP — Date: -

Approval: DEH — Date: 9/90

Drawing No. — Rev. 1 3/93

HANSEN ALLEN & LUCE INC. Salt Lake City Utah

SCALE: 1" = 2000' SHEET 1 of 1

007.11.100.001

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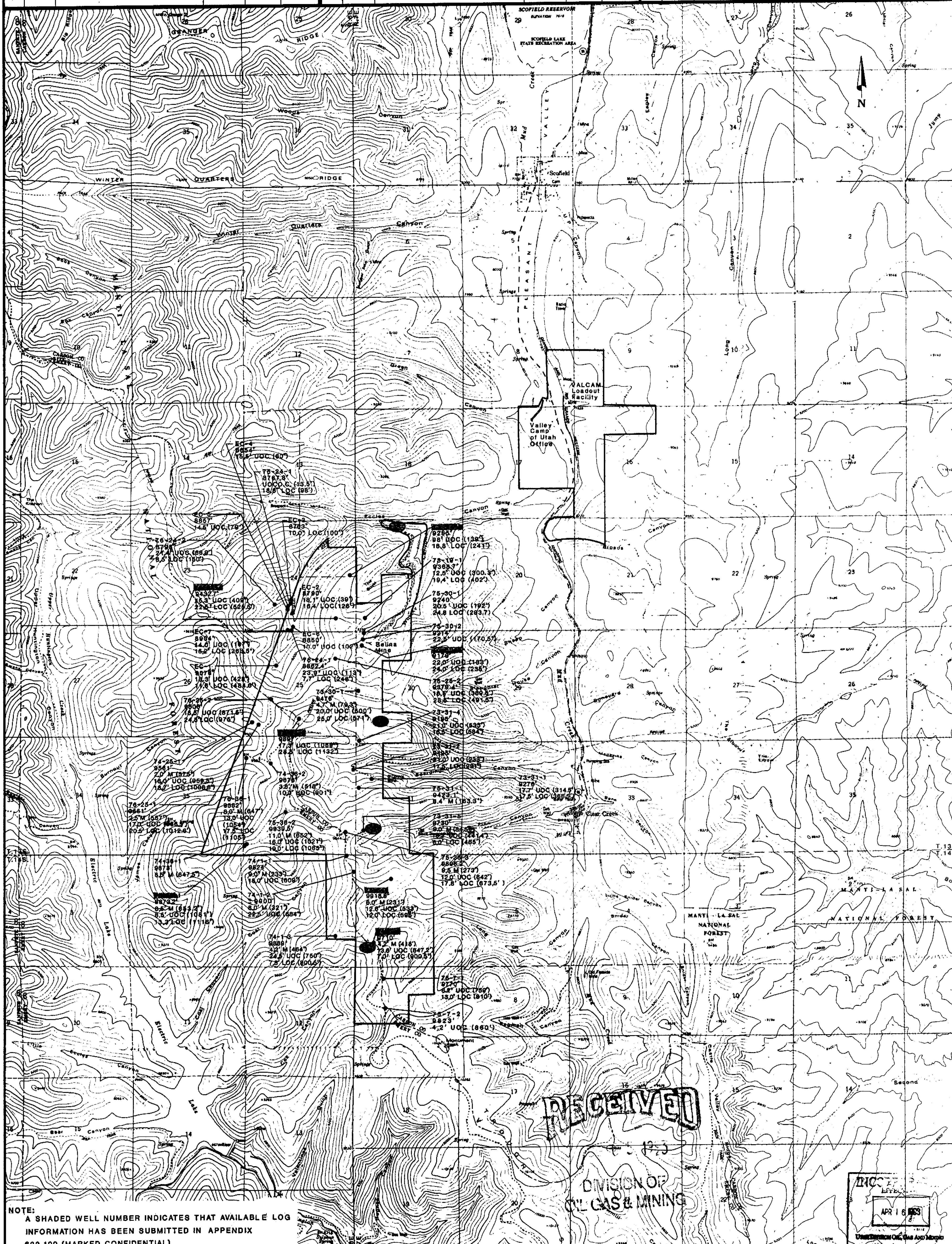

NOTE:
A SHADED WELL NUMBER INDICATES THAT AVAILABLE LOG INFORMATION HAS BEEN SUBMITTED IN APPENDIX 622.100 (MARKED CONFIDENTIAL)

LEGEND:

74-6-1	WELL NUMBER. (SHADING INDICATES WELL LOG SUBMITTED)
9899'	GROUND ELEVATION
4.2' M (464')	4.2' THICK MCKINNON SEAM AT 464' DEPTH
24.5' UOC (750')	24.5' THICK UPPER O'CONNOR SEAM AT 756' DEPTH
7.8' LOC (800.5')	7.8' THICK LOWER O'CONNOR SEAM AT 800.5' DEPTH
M	MCKINNON COAL SEAM
UOC	UPPER O'CONNOR COAL SEAM
LOC	LOWER O'CONNOR COAL SEAM
UOC O.C.	UPPER O'CONNOR COAL OUTCROP

GAS WELL

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VALLEY CAMP OF UTAH, INC.

SCOFIELD ROUTE, HELPER, UTAH 84526

TITLE:
MAP R645-301-622.100a
DRILL HOLE AND GAS WELL LOCATIONS WITH COAL SEAM DATA

Drawn by: DCR	Date: 7/89
Approval: DEH	Date: 9/90
Drawing No.	Rev. 1 3/93

HANSEN ALLEN & LUCE Salt Lake City Utah

SCALE: 1" = 2,000'

SHEET 1 OF 1

007.11.100.002

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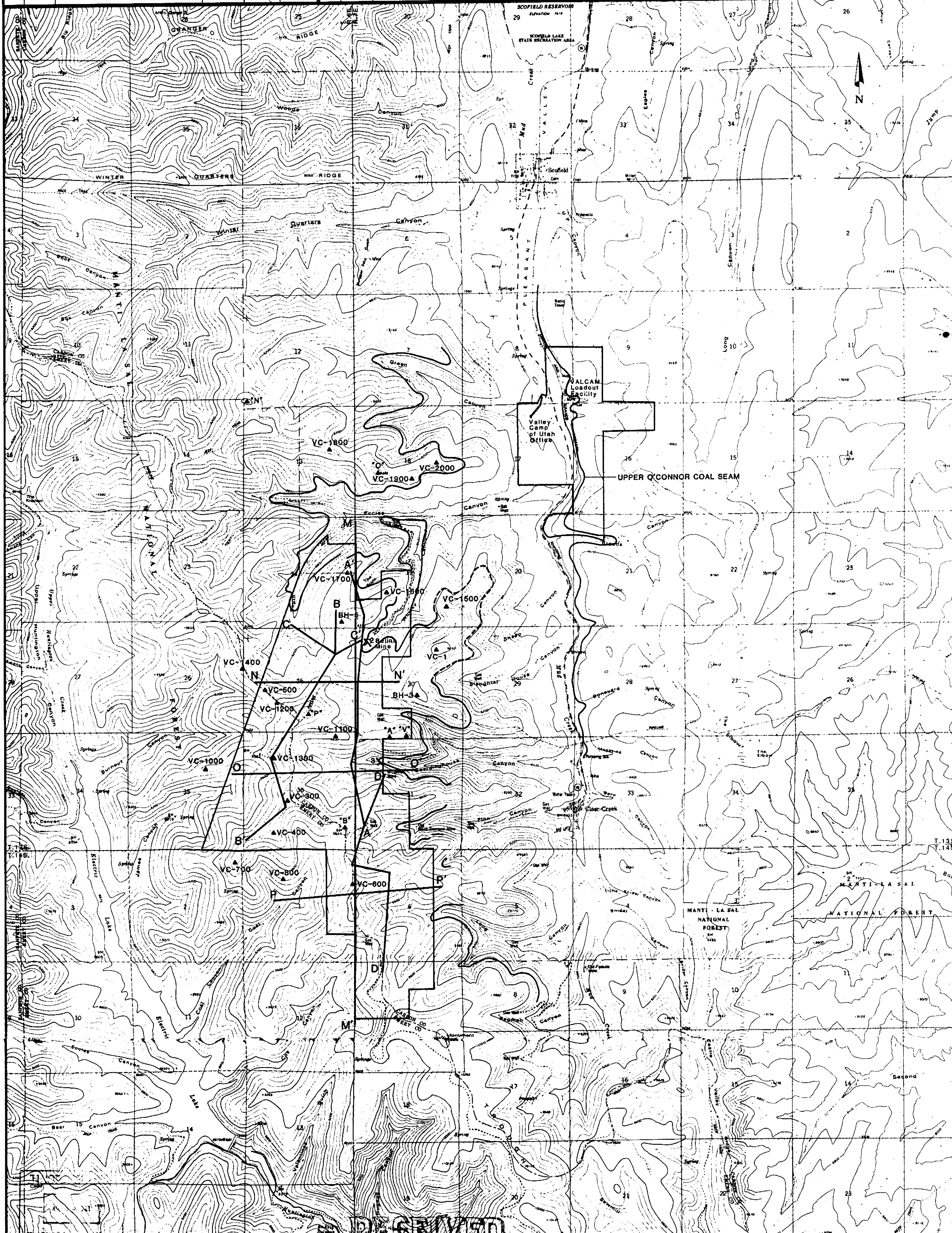

LEGEND:

A — A' STRATIGRAPHIC GEOLOGIC CROSS SECTION

M — M' GEOLOGIC/HYDROLOGIC CROSS SECTION

APPROXIMATE LOCATION OF O'CONNER COAL OUTCROP (UPPER AND/OR LOWER SEAMS) – DASHED WHERE INFERRED

STRIKE AND DIP OF COAL SEAM

▲VC-800 SUBSIDENCE MONITORING MONUMENT AND NUMBER

RECEIVED

DIVISION OF OIL GAS & MINING

CERTIFICATION

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#7888 DAVID E. HANSEN

VALLEY CAMP OF UTAH, INC.

SCOFIELD ROUTE, HELPER, UTAH 84526

TITLE: MAP R645-301-622.200a GEOLOGIC CROSS SECTIONS, COAL OUTCROP & FOREST SERVICE SUBSIDENCE MONITORING LOCATION MAP

Drawn by: DCR	Date: 7/89
Approval: DEH	Date: 9/90
Drawing No.	Rev. 1 3/93

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SCALE: 1" = 2000' SHEET 1 OF 1

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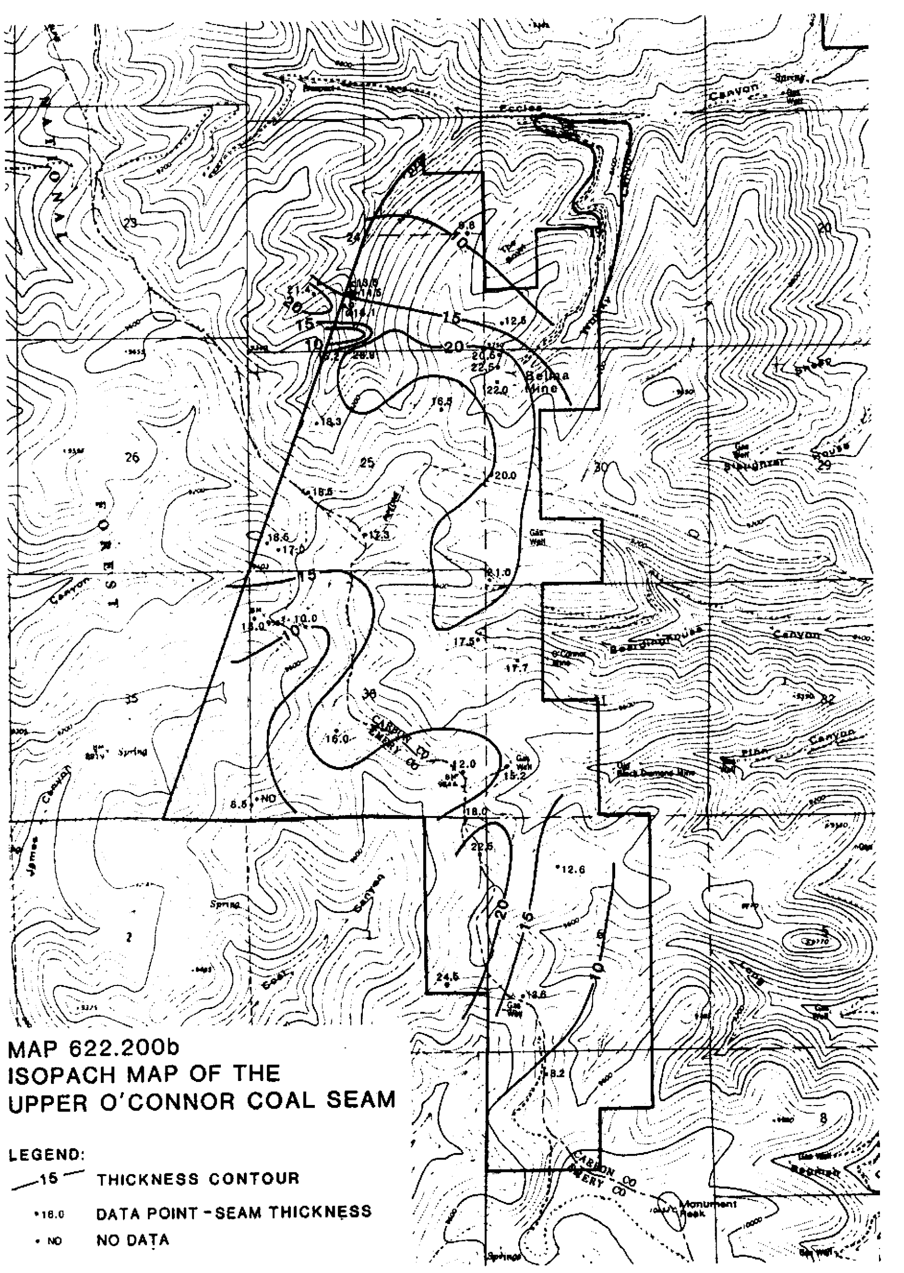
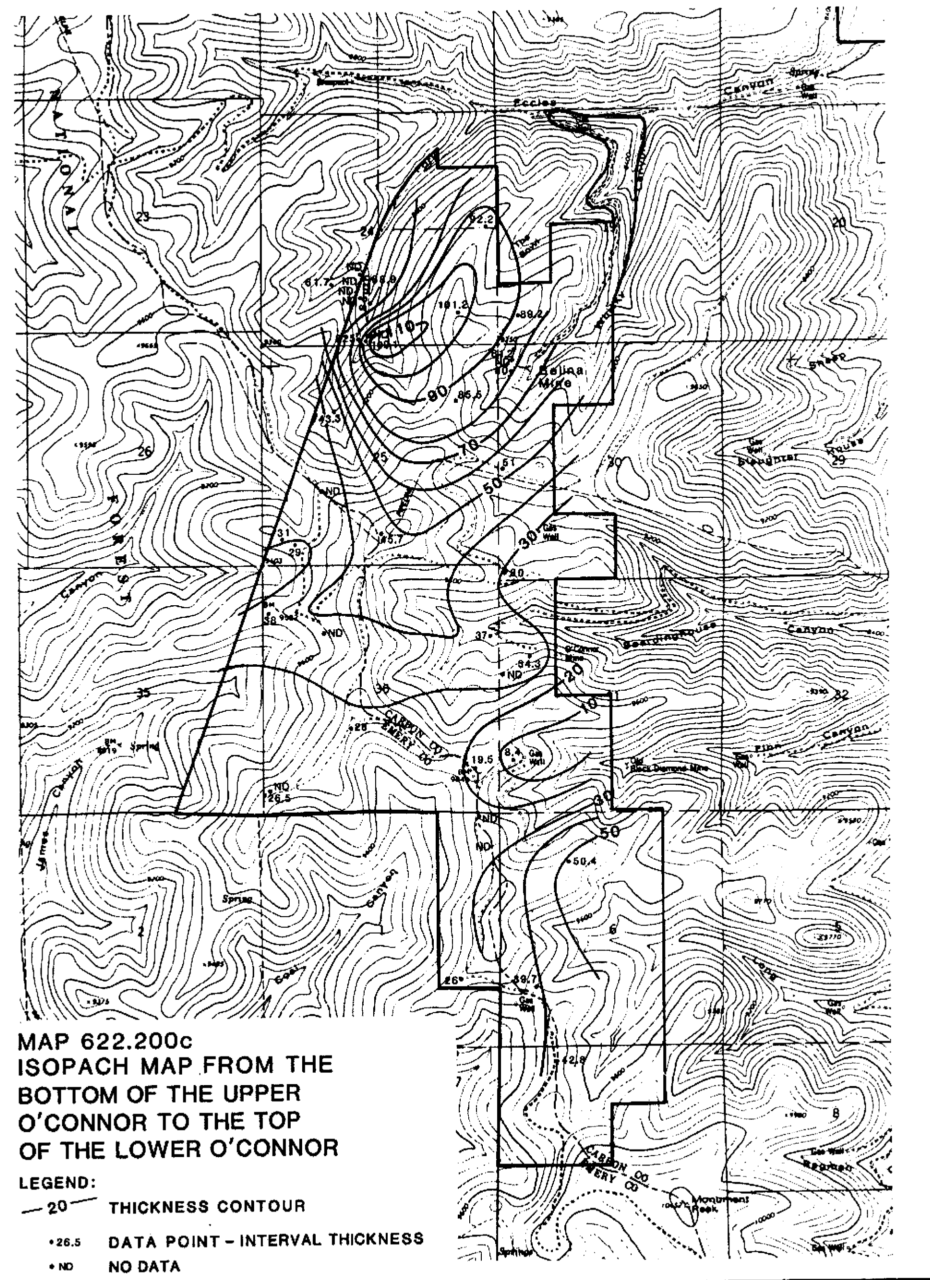


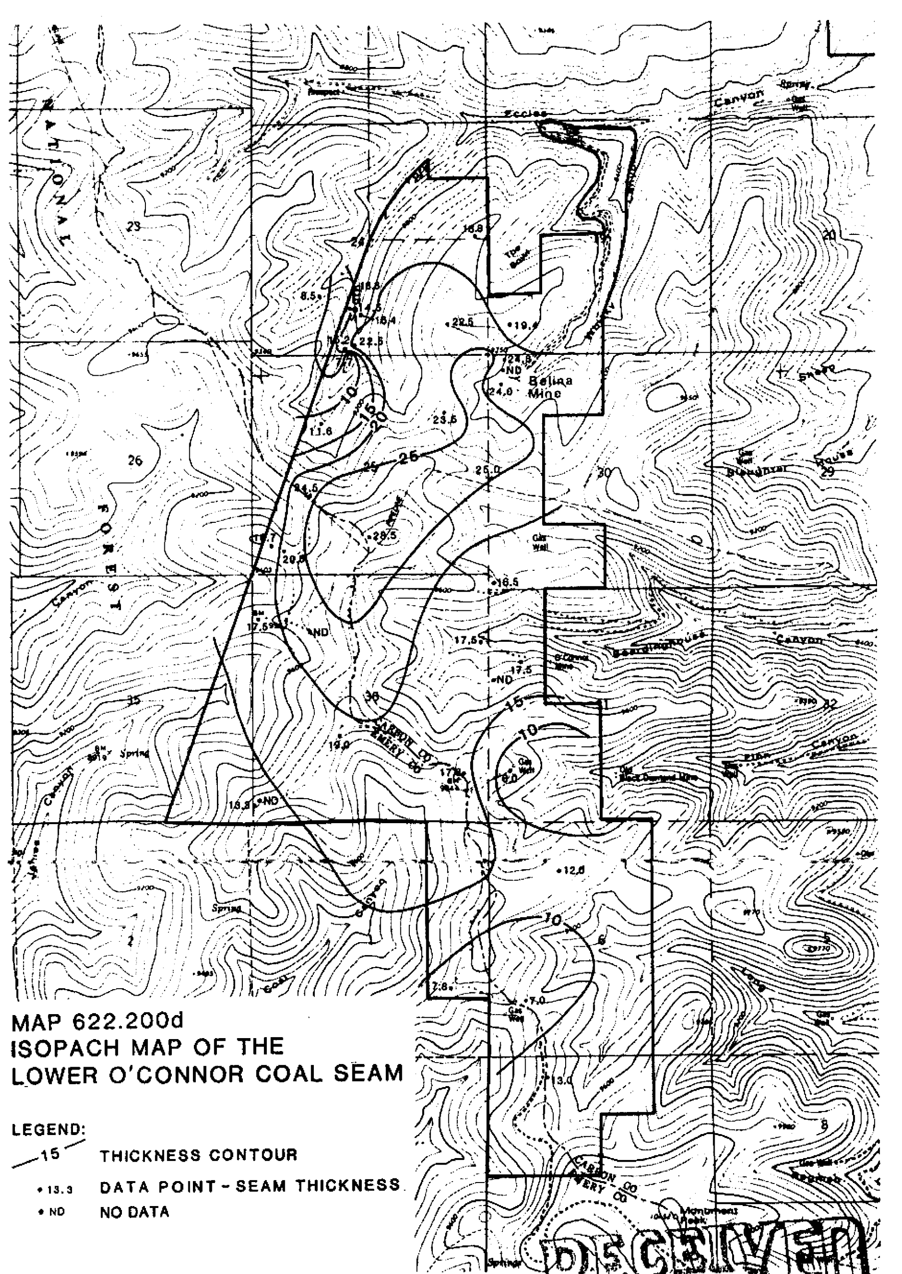
MAP 622.200b
ISOPACH MAP OF THE
UPPER O'CONNOR COAL SEAM

LEGEND:
15 THICKNESS CONTOUR
•16.0 DATA POINT - SEAM THICKNESS
• ND NO DATA



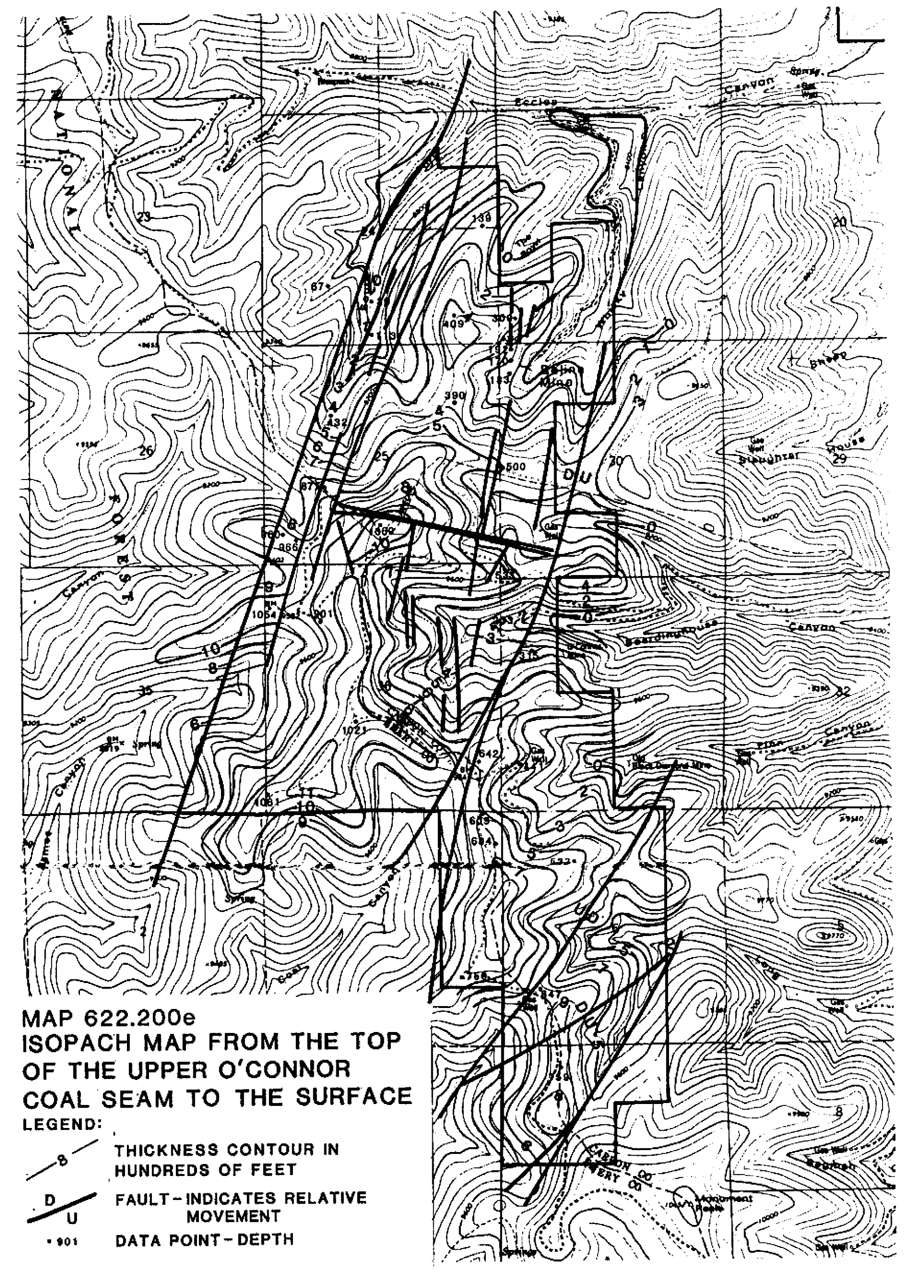
MAP 622.200c
ISOPACH MAP FROM THE
BOTTOM OF THE UPPER
O'CONNOR TO THE TOP
OF THE LOWER O'CONNOR

LEGEND:
20 THICKNESS CONTOUR
•26.5 DATA POINT - INTERVAL THICKNESS
• ND NO DATA



MAP 622.200d
ISOPACH MAP OF THE
LOWER O'CONNOR COAL SEAM

LEGEND:
15 THICKNESS CONTOUR
•13.3 DATA POINT - SEAM THICKNESS
• ND NO DATA



MAP 622.200e
ISOPACH MAP FROM THE TOP
OF THE UPPER O'CONNOR
COAL SEAM TO THE SURFACE

LEGEND:
8 THICKNESS CONTOUR IN HUNDREDS OF FEET
D/U FAULT - INDICATES RELATIVE MOVEMENT
•901 DATA POINT - DEPTH

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SCOFIELD ROUTE, HELPER, UTAH 84526

TITLE:	Drawn by: DCR	Date: 8/89
MAPS R645-301-622.200b THROUGH R645-301-622.200e ISOPACH MAPS	Approval: DEH	Date: 9/90
	Drawing No.	Rev. 1 3/93
HANSEN ALLEN & LUCE Salt Lake City Utah	SCALE: 1"=2000'	SHEET 1 OF 1

007.11.100.004

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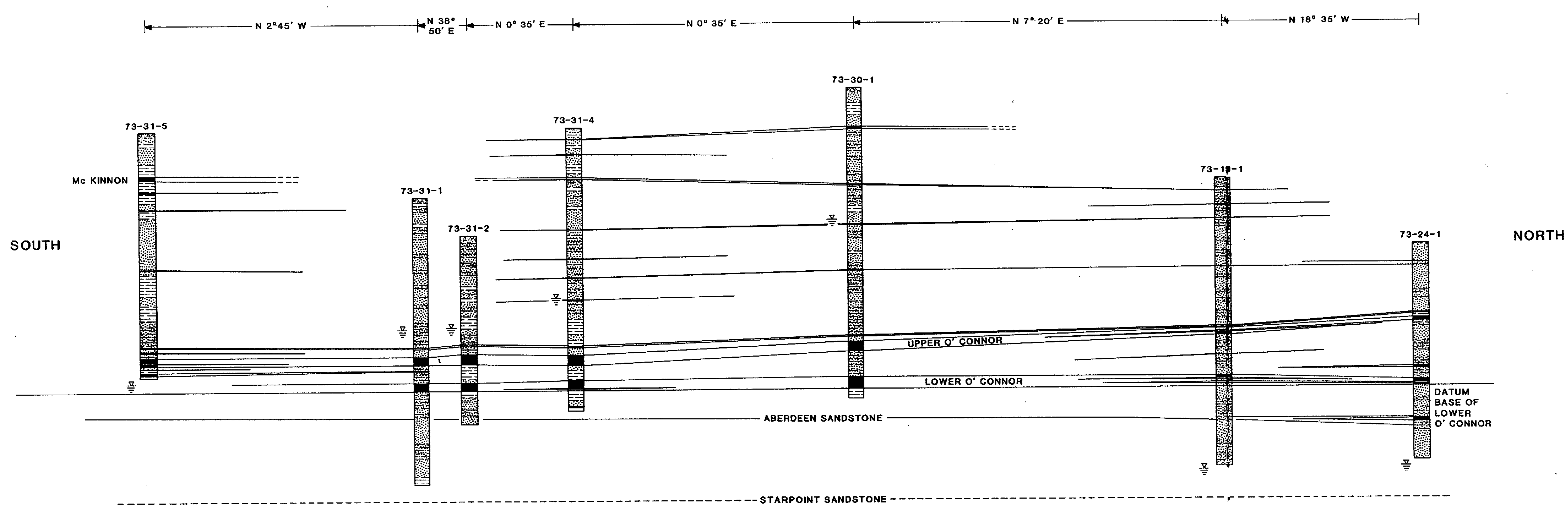

VERTICAL SCALE: 1" = 100'
HORIZONTAL SCALE: 1" = 500'

LEGEND:

- GRAVEL AND ALLUVIUM
- SANDSTONE
- SHALE
- COAL
- 73-30-1 WELL NUMBER
- ← N 7° 20' E BEARING
- APPROXIMATE WATER TABLE LEVEL

NOTE: LOCATION OF CROSS SECTION SHOWN ON MAP 622.200a

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TITLE: FIGURE R645-301-622.200f
STRATIGRAPHIC GEOLOGIC
CROSS SECTION A-A'

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Approval: DEH | Date: 9/90
Drawing No. | Rev. 1 3/93

HANSEN ALLEN & LUCE Salt Lake City Utah

SCALE: AS SHOWN | SHEET 1 OF 1

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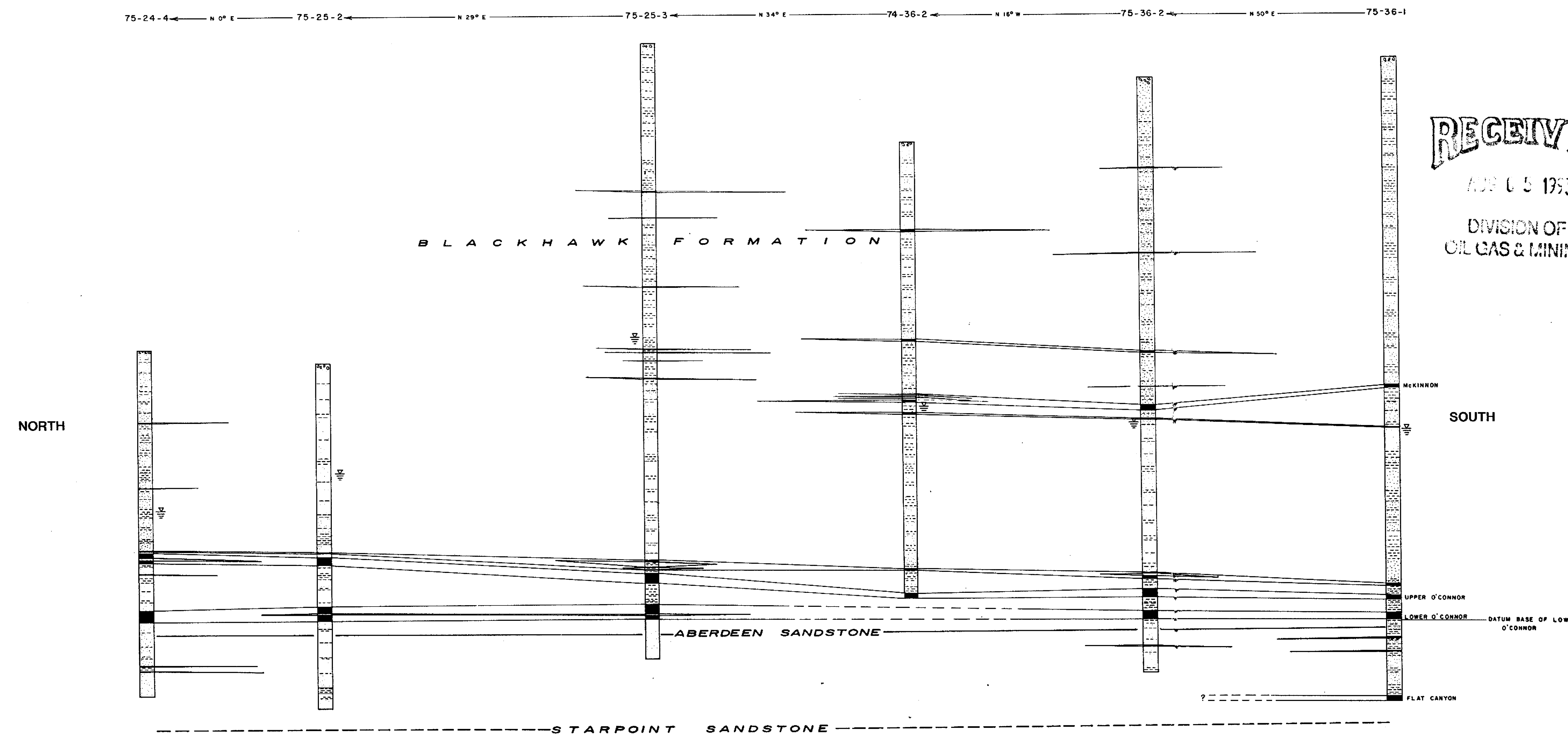

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VERTICAL SCALE: 1"=100'
HORIZONTAL SCALE: 1" = 200'

LEGEND:

- GRAVEL AND ALLUVIUM
- SANDSTONE
- SHALE
- COAL
- 75-36-1 WELL NUMBER
- N 50° E BEARING
- APPROXIMATE WATER TABLE LEVEL

NOTE: LOCATION OF CROSS SECTION SHOWN ON MAP 622.200a

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TITLE:

FIGURE R645-301-622.200g
STRATIGRAPHIC GEOLOGIC
CROSS SECTION B-B'

Drawn by: KCF(VALLEY CAMP)	Date: 9/9/83
Approval: DEH	Date: 9/90
Drawing No. VALLEY CAMP NO. D5-0087	Rev. 1 3/93

HANSEN ALLEN & LUCE Salt Lake City Utah

SCALE: AS SHOWN | SHEET 1 OF 1

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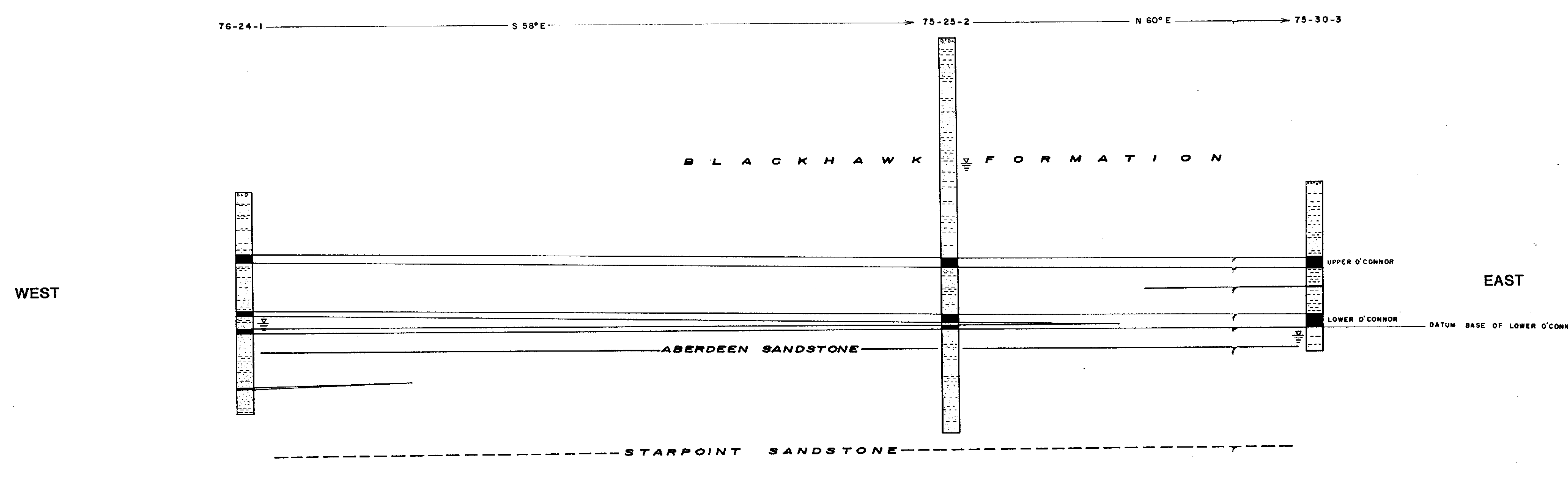

VERTICAL SCALE: 1"=100'
HORIZONTAL SCALE: 1" = 200'

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LEGEND:
- GRAVEL AND ALLUVIUM
- SANDSTONE
- SHALE
- COAL
- 75-30-3 WELL NUMBER
- ← N 60° E BEARING
- APPROXIMATE WATER TABLE LEVEL

NOTE: LOCATION OF CROSS SECTION SHOWN ON MAP 622.200a

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TITLE:
FIGURE R645-301-622.200h
STRATIGRAPHIC GEOLOGIC
CROSS SECTION C-C'

Drawn by: KCF(VALLEY CAMP) Date: 9/9/83
Approval: DEH Date: 9/90
Drawing No. D5-0088 Rev. 1 3/93

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SCALE: AS SHOWN SHEET 1 OF 1

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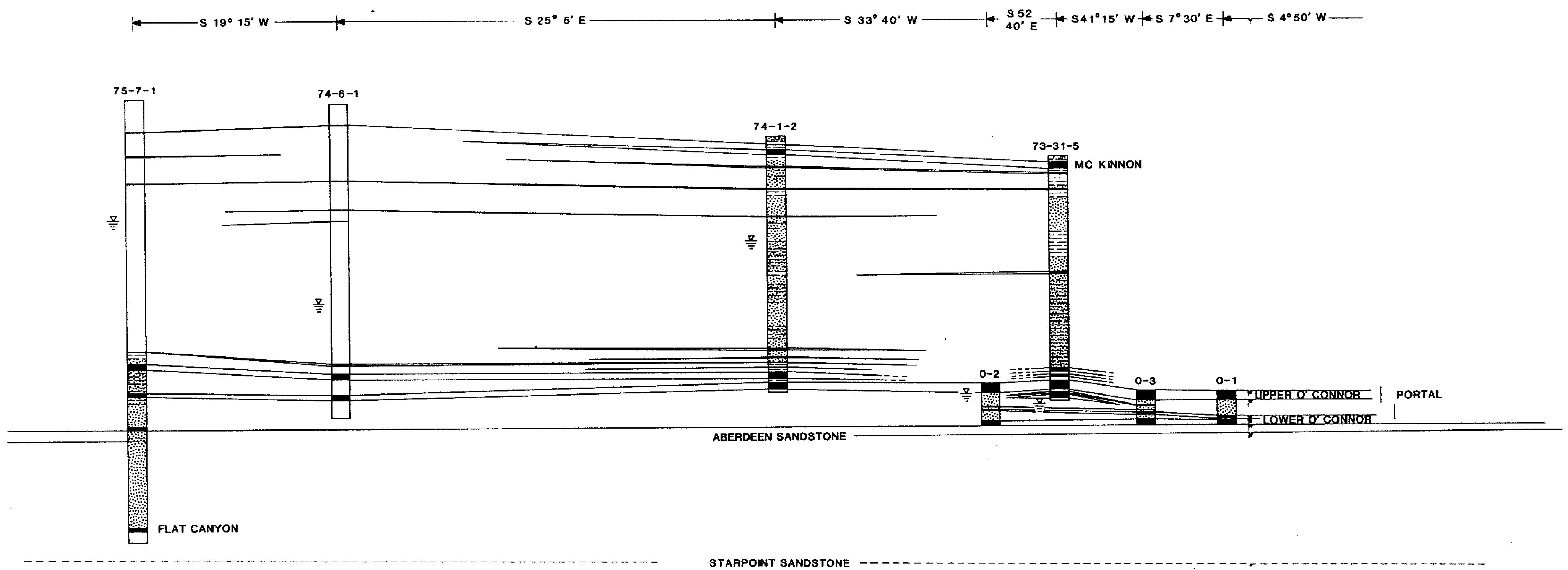

VERTICAL SCALE: 1"=100'
HORIZONTAL SCALE: 1"= 500'

LEGEND:

- GRAVEL AND ALLUVIUM
- SANDSTONE
- SHALE
- COAL
- 0-1 WELL NUMBER
- ← S 4° 50' W BEARING
- APPROXIMATE WATER TABLE LEVEL

NOTE: LOCATION OF CROSS SECTION SHOWN ON MAP 622.200a

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TITLE: FIGURE R645-301-622.200i
STRATIGRAPHIC GEOLOGIC
CROSS SECTION D-D'

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SCALE: AS SHOWN | SHEET 1 OF 1

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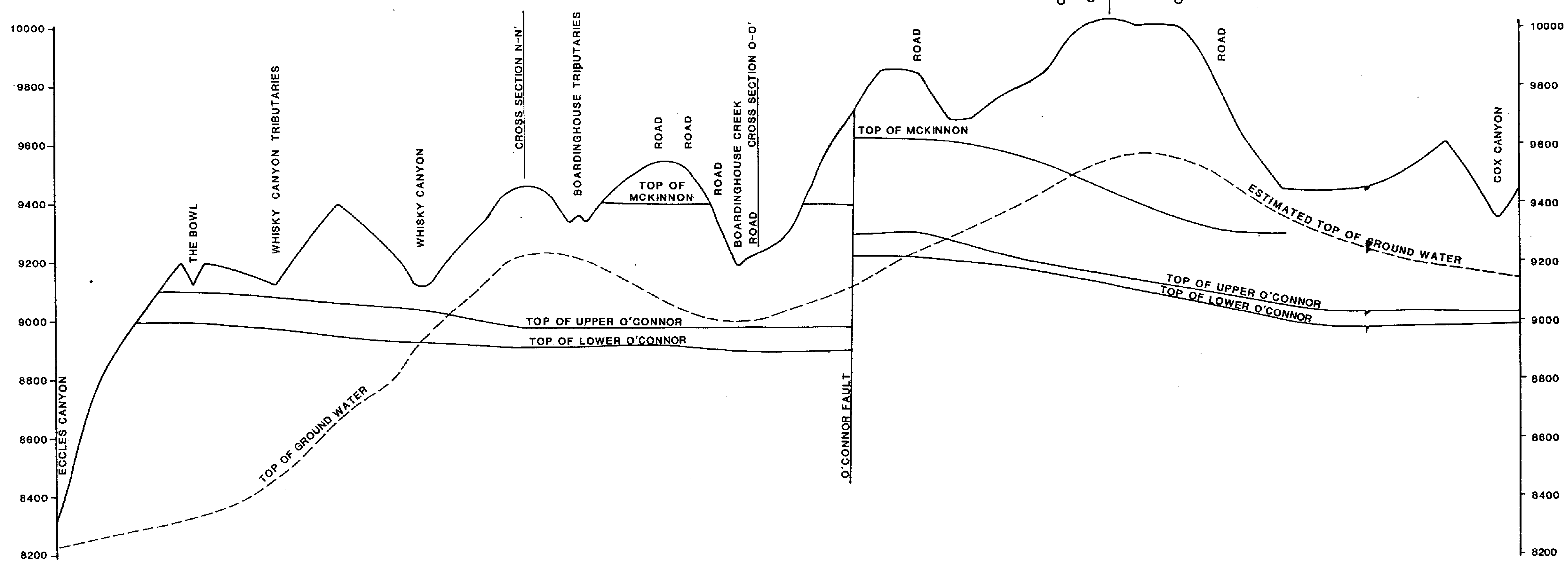
NO.	DATE	DESCRIPTION	REF. NO.	DATE	INITIALS

VALLEY CAMP ACT/007/001 REVISION			INCORPORATED INTO MRP BY DOGM		
NO.	DATE	DESCRIPTION	REF. NO.	DATE	INITIALS

CROSS SECTION M-M'



VERTICAL SCALE: 1" = 200'
HORIZONTAL SCALE: 1" =1000'

622.200

NOTE: LOCATION OF CROSS SECTION SHOWN ON MAP 622.200a

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TITLE:
FIGURE R645-301-622.200j
GEOLOGIC/HYDROLOGIC
CROSS-SECTION M-M'

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Approval: DEH	Date: 9/90
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SCALE: AS SHOWN

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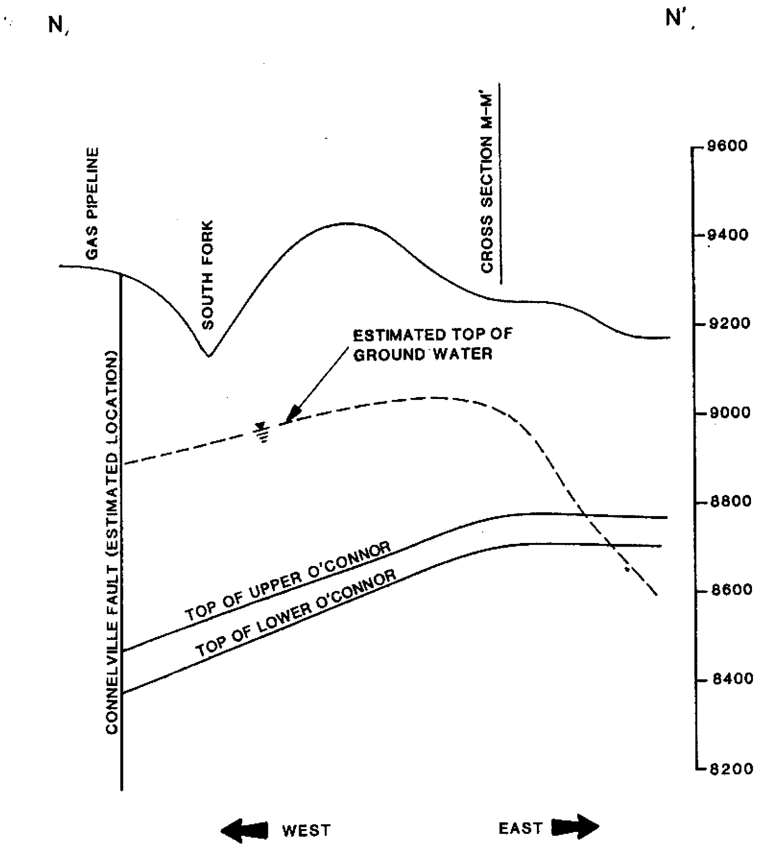

FIGURE 622.200k
GEOLOGIC/HYDROLOGIC
CROSS SECTION N-N'

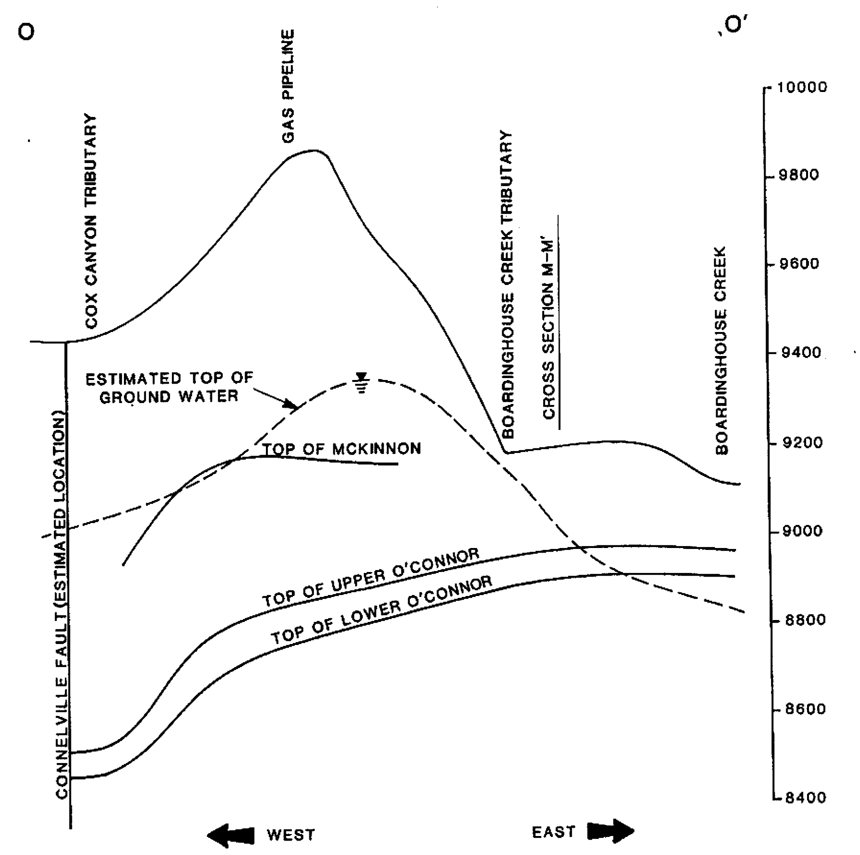

FIGURE 622.200l
GEOLOGIC/HYDROLOGIC
CROSS SECTION O-O'

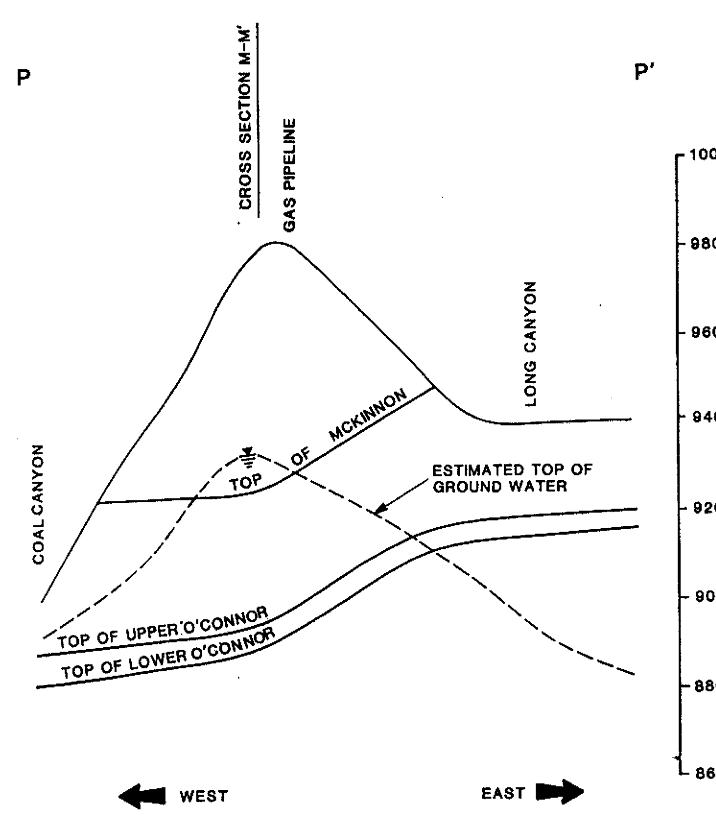

FIGURE 622.200m
GEOLOGIC/HYDROLOGIC
CROSS SECTION P-P'

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NOTE: LOCATION OF CROSS SECTIONS SHOWN ON MAP 622.200a

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STATE OF UTAH

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TITLE:
FIGURES R645-301-622.200k
TO R645-301-622.2000m
GEOLOGIC/HYDROLOGIC
CROSS SECTIONS N-N', O-O' & P-P'

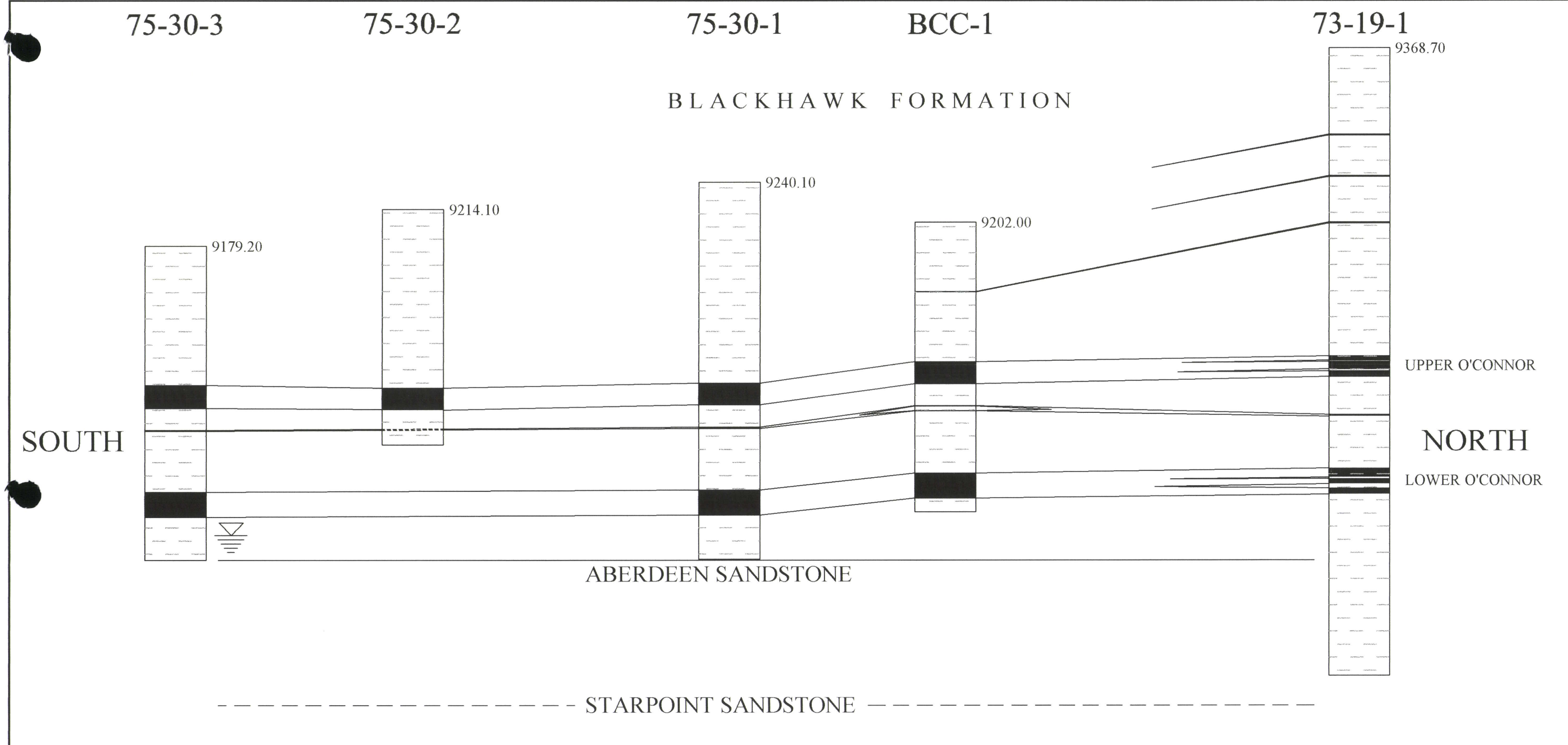
Drawn by: VALLEY CAMP		Date: -	
Approval: DEH		Date: 9/90	
Drawing No.		Rev. 1 3/93	

HANSEN ALLEN & LUCE INC Salt Lake City Utah

SCALE: 1" = 1000' H 1" = 200' V

SHEET 1 OF 1

007.11.100.010



LEGEND:

COAL

STRATA

75-30-3 WELL NUMBER

APPROXIMATE WATER TABLE LEVEL

CROSS SECTION ON PLATE 5-1 D & E

REGISTERED PROFESSIONAL ENGINEER
No. 7418
DAVID B. MILLER
8/30/01
NOT VALID WITHOUT SIGNATURE
STATE OF UTAH

Lodestar Energy Inc.
Mountain Operations, White Oak Mine
HC 35, Box 370, Helper Ut. 84526
PH #: 435-637-9200 Fax #: 435-448-9456

Drawn By: Kit Pappas	Date: August 30, 2001	Scale: 1" = 200'
Approval: Dave Miller	Drawing Location: C:\KIT\GEO-COLUMN	

TITLE: FIGURE R645-301-622.200n
SURFACE MINING STRATAGRAPHIC
GEOLOGIC CROSS SECTION